SANTA CLARA VALLEY WATER DISTRICT

DEVELOPMENT OF REGIONAL REGRESSION EQUATIONS TO CALCULATE FLOOD QUANTILES IN SANTA CLARA COUNTY

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1 INTRODUCTION

This study, authorized by Santa Clara Valley Water District on June 16, 2003, presents a flood quantile estimation technique based on the Stepwise Multiple Linear Regression of dependent and independent variables. In this case, the dependent variables are the quantiles of the log domain of recorded instantaneous flood peaks and 24-hr volumes. The independent variables, however, are the transformed basin characteristics such as area, mean annual precipitation, slope, and a basin factor. The flood quantiles of interest in this study are those that have the following probabilities of occurrence: 0.5%, 1%, 10% and 50%.

This study is considered to be an update of the 1976 linear equation (1), and of the 1996 linear, multiplicative and statistically based equations (4).

2 SUMMARY OF FINDINGS

The following is the final set of regression equations that were developed in this study. This set of equations was selected from many equations that were developed using different combinations of quantiles of maximum annuals of recorded streamflow data at various locations and watershed sizes. The locations of the data points were chosen from the study area as defined in Article 4.2 below and shown on the map in **Appendix 1**.

As shown below, the dependent variable in these equations is the quantile ***(Q)*** of flows, while the independent variable is the area ***(A)*** in square miles as obtained from the USGS 7.5 min quad maps, and the mean annual precipitation ***(P)*** as obtained from the SCVWD map (6).

The primary criterion used in the selection of these equations is based on achieving maximum determination coefficients and minimum standard error of estimates. In addition, the selection of the final set of equations was based on the results of extensive application and testing of equations on watersheds within Santa Clara County. The objective is to ensure that the chosen equations produce quantiles that are monotonic for various probabilities and consistent within and between watersheds.

Although that the equations below are shown in the multiplicative form, their development was based on the linear analysis.

The results from these regression equations are used to calibrate rainfall generated design flows in Santa Clara County.

Instantaneous Peak Flows from Small and Large Drainage Area:

1. Equation (9S-LQ200) representing the instantaneous 200-year flood peak

$$Q\ 0.5\% = 14.158 * A^{0.946} * P^{1.005}$$

Where: $R^2 = 0.963$ and $\varepsilon = 0.146$

And
$Q\ 0.5\%$ = Two hundred year flood peak in cfs
A = Drainage area in square miles
P = Mean Annual Precipitation in inches
R^2 = Determination coefficient
ε = Standard error of estimate

2. Equation (9S-LQ100) representing the instantaneous 100-year flood peak

$$Q\ 1\% = 11.22 * A^{0.954} * P^{1.03}$$

Where: $R^2 = 0.964$ and $\varepsilon = 0.145$

3. Equation (9S-LQ10) representing the instantaneous 10-year flood peak

$$Q\ 10\% = 2.985 * A^{0.988} * P^{1.173}$$

Where: $R^2 = 0.947$ and $\varepsilon = 0.185$

4. Equation (9S-LQ2) representing the instantaneous 2-year flood peak

$$Q\ 50\% = 0.323 * A^{1.00} * P^{1.437}$$

Where: $R^2 = 0.866$ and $\varepsilon = 0.316$

1-Day Flood Volumes

Note: The 24-Hr volume is equal to the 1-day volume multiplied by the approximate value of 1.15

1. Equation (9V1D200) representing the 200-year 1-day flood volume in cfs

$$V\ 0.5\% = 2.600 * A^{0.967} * P^{1.188}$$

Where: $R^2 = 0.921$ and $\varepsilon = 0.139$

2. Equation (9V1D100) representing the 100-year 1-day volume in cfs

$$V\ 1\% = 2.254 * A^{0.964} * P^{1.187}$$

Where: $R^2 = 0.927$ and $\varepsilon = 0.133$

3. Equation (9V1D10) representing the 10-year 1-day flood volume in cfs

$$V\ 10\% = 0.895 * A^{0.933} * P^{1.244}$$

Where: $R^2 = 0.932$ and $\varepsilon = 0.125$

4. Equation (9V1D2) representing the 2-year 1-day flood volume

$$V\ 50\% = 0.11 * A^{0.861}\ P^{1.51}$$

Where: $R^2 = 0.83$ and $\varepsilon = 0.197$

3 PREVIOUS EQUATIONS

3.1 Introduction

The Santa Clara Valley Water District developed the design flood flows for flood control projects based on the best available streamflow information. For ungaged locations, the best available streamflow information were transferred from gaged locations using the above mentioned regression techniques. The flood quantiles of defined probabilities obtained from regression are used to calibrate flood flows obtained from watershed rainfall-runoff modeling. Given the complexities of the rainfall-runoff transformation process, it was understood that such calibration would reduce the compounding of probabilities that could result form generating flood quantiles of certain probabilities from rainfall quantiles of the same probabilities.

The following is a short description of the earlier regression models that were developed in 1976. They are provided herein for comparison purposes.

3.2 1976 Regression Model

In 1976, the first Regional Regression Equations were developed for Santa Clara County using the recorded streamflow data from the County without including data from adjacent areas (1). At that time, the average length of record was approximately equal to 20 years, hardly enough for the calculation of statistical parameters (moments) or quantiles with reasonable standard error of estimates.

For this reason, the maximum annuals of peaks, 1-day, 2-day and 3-day volumes were stochastically expanded to generate one trace of expanded and recorded time series of flood flows for each duration. It was necessary to ensure that expansion of data increases the information content according to Myron Fiering information content criteria (2).

Needed statistics were calculated from such data by using Bulletin 17 with its shortcoming in testing and removing outliers and adjusting the statistics. Bulletin 17 was developed in the mid seventies, based on log-Pearson Type III distribution and a weighted third moment (3).

The emphasis of the 1976 study was to develop global equations for the mean (M) and standard deviation (σ) of the above mentioned flood peaks and volumes rather than specific equations for flood quantiles. The design quantiles, however, were developed using the general statistical formula $Q = M + k\,\sigma$ where k is a PT III distribution factor for a given skew. In addition equations for the 1% flood quantiles were developed for comparison only.

The error analysis of the 1976 equations showed that while the determination coefficients and standard errors are acceptable for the means, such is hardly the case for the standard deviations. The equivalent years of record for the mean obtained from regression were in excess of 20 years while for the standard deviation the equivalent years of record were less than 10 years. That scenario represented the best available information at locations with no recorded data. Again, those equations produced conservative results that represented the best available information at that time.

The following are the 1976 equations:

Peaks

$$M = 0.148 + .68 \operatorname{Log} A + 1.25 \operatorname{Log} P$$

$$\sigma = 1.65\, P^{-0.45}\, LLS^{0.05}$$

$$1\%\ Q = 238\, A^{0.84}\, P^{0.23}$$

Where:

M = *Mean of Maximum Annual Flows*
σ = *Standard Deviation of MAF*
A = *Area of watershed in Sq. Mi*
P = *Average Mean Annual Precipitation*
LLS = *Basin Factor as defined later in the Report*

24-HR Volumes

$$M = -0.756 + .83 \operatorname{Log} A + 1.51 \operatorname{Log} P$$

$$\sigma = 1.752\, P^{-.46}\, LLS^{0.05}$$

$$1\%\ Q = 8.558\, A^{0.98}\, P\, .67\, S^{-0.10}$$

1-Day Volume

$$M = -1.039 + 0.88 \operatorname{Log} A + 1.60 \operatorname{Log} P$$

$$\sigma = 1.752\, P^{-.46}\, LLS^{.05}$$

$$1\%\ Q = 8.558\, A^{0.98}\, P\, .67\, Sm^{-.10}$$

2- Day Volume

$$M = -.898 + .88 \operatorname{Log} A + 1.61 \operatorname{Log} P$$

$$\sigma = 1.872\, P^{-.47}\, LLS^{.04}$$

$$1\%\ Q = 11.165\, A^{.96}\, P\, .69\, S^{-.12}$$

3-Day Volume

$$M = -.859 + .88 \operatorname{Log} A + 1.64 \operatorname{Log} P$$

$$\sigma = 1.949\, P^{-.48}\, LLS^{.04}$$

$$1\% = 10.206\, A^{.95}\, P\, .75\, S^{-.15}$$

Note 1: The adjusted Determination Coefficients (R^2) for the mean (*M*) and for the 1% quantiles range from 0.817 to 0.967. For the standard deviations (σ) the R^2 range from 0.462 to 0.514

3.3 1996 Regression Study

In 1996, the above-mentioned 1976 study was updated and spatially expanded to include all rainfall and runoff data from the eight counties around the San Francisco and Monterey Bays (4). The data were then stochastically expanded and filled-in and fifty traces of such data were generated for all durations. The statistics (means, standard deviations, skews and quantiles) for each trace were calculated using WRC Bulletin 17B, and averaged to develop the dependent variables in the regression analyses. The independent variables, however, were the same as defined for the 1976 study. Areas, mean annual precipitations, slopes, lengths, and basin factor of corresponding watersheds were all considered with some transformations. The regression analyses were based on log-linear and non-linear (multiplicative and statistical based) mathematical models. Many equations were developed and used to define the flood quantiles and other statistics within this hydrometeorologic region.

The extensive testing of those equations produced some inconsistencies when applied to small basins in Santa Clara County. Moreover, the results from the Multiplicative model were found to have irreconcilable differences with results from the linear and the statistically based models. At times, these models overestimated quantiles from small drainage areas while underestimated them from larger ones. The linear model, however, produced more consistent results than the others, but not enough to replace the site specific 1976 models for Santa Clara County. This is explained by the fact that the 1996 models were based on stochastically filled-in and expanded data that cover a very wide area (eight counties) with larger watersheds.

For counties other than Santa Clara that were included in the 1996 study, those equations could be used to calculate design flood flows from ungaged rural locations when site specific information are not available.

4 2002 REGRESSION STUDY

4.1 Introduction

Notwithstanding the assumptions that were made in developing the previous regression equations, and given the older data used in the previous studies, the District decided to update its regression equations based on the following criteria:

1. Update the recorded streamflow data where possible.
2. Use the historic record only (no stochastic extension).
3. Use WRC Bulletin 17B to calculate quantiles (same as 1996 study).
4. Use the logs of quantiles, rather than the statistics, as the dependent variables.
5. Use the data from Santa Clara and Santa Cruz counties only.
6. Use a step-wise multiple linear regression technique to define the final form of regression rather than the multiplicative or statistical based.
7. Use the minimum number of independent variables without reducing the determination coefficient.

4.2 Basic Data and Frequency analysis

The USGS and SCVWD maximum annual streamflow data with above mentioned criteria are taken from the 1996 study and updated by SCVWD to include maximum annuals through 2000. Although the data used in the 1996 study covers the eight Bay Area and Monterey Counties, the data that are used in this study are limited to the immediate areas near Santa Clara and Santa Cruz Counties. The map in **Appendix 1** shows the study area and the location of all stations.

The frequency analysis to determine the flood quantiles was based on the Water Resources Council Bulletin 17B (5) using the USACE Flood Frequency Analysis (FFA) program (7). This technique is based on the method of moments where the logs of maximum annuals follow a Log Pearson Type III distribution. The final skew factors (third moments) for such a distribution were calculated from the weighted average of recorded and regional skew factors, where the regional skew factor is equal to (-0.7) as determined in the 1996.

In the absence of detailed qualification of data, the acceptability of flood quantiles were further determined by using an arbitrary acceptability factor ***(F)*** shown below:

$$F = Q1\% / A*P$$

Where:

$(Q1\%)$ = 1% flood quantile of peaks and volumes
(P) = Mean annual precipitations
(A) = Areas in square miles

The quantiles of peak flows are said to be acceptable in this study if the factor (***F***) is between 7 and 19. Similarly, for flood volumes, the quantiles are acceptable when the factors are between 2 and 9. It was observed that if the data are obtained from excessively large drainage areas, regulated by reservoirs, short, having missing records, or collected with no acceptable guidelines for maintenance and collection procedures, ***(F)*** usually falls beyond those limits. This is evident, for example, in the case of Matadero Creek @ Palo Alto and Los Trancos Cr. @ Stanford University that are located in close proximity of each other. Matadero Cr. has a drainage area equal to 7.3 square miles and an MAP equal to 25 inches, while Los Trancos has a larger area of 7.5 square miles and a higher MAP of 32 inches. However, the Q1% from Matadero is equal to 1930 cfs far much more than the Q1% from Los Trancos of 1100 cfs. Furthermore, **Table-1** shows that the ***(F)*** factor for Matadero is equal to 11, while for Los Trancos is equal to 5. If compared with other stations in the data set it is obvious that Matadero, which is one of the basic qualified USGS stations, is more consistent with other stations. Therefore, Matadero was used while Los Trancos was rejected from regression.

In addition to the quantiles, **Table-1** shows the respective watershed parameters. Similarly, **Table–2** shows the same for the1-day volumes.

Table-1: Data Used in the Regression Analyses of the Instantaneous Peak flows

Station ID	Station Name	A SM	P In	Slope	L mi	LLS mi.mi	0.5%	1%	10%	50%	1%Q/ A	1%/ A*P
11152000	ARROYO SECO NR SOLEDAD	244	35	0.0125	28.91	3265.9	41700	36900	20000	7380	151	4
11180500	DRY CREEK AT UNION CITY	9.4	20	0.0231	5.06	132.5	4330	3570	1240	182	380	19
11 176400	ARROYO VALLE NR LIVERMOOR	130	21	0.0061	32.35	5177	22500	18500	7040	1470	142	7
11166000	MATADERO C AT PALO ALTO	7.3	25	0.015	6.25	164.3	2170	1930	1070	385	264	11
11163500	LOS TRANCOS C AT STANFORD U	7.5	32	0.0284	7.01	145.8	1240	1100	601	239	147	5
11173200	ARROYO HONDO NEAR SAN JOSE	77.1	25	0.009	25.76	3239	14100	13300	8780	3470	173	7
64	*Berryessa Ck above Calaveras Rd.*	*15.12*	*17*	*0.055*	*8.75*	*183.4*	*4570*	*4060*	*2200*	*771*	*269*	*16*
74	Sunnyvale East @ Bayshore Freeway	6.19	15	0.0081	5.78	176.6	652	624	519	409	101	7
33	Hale Ck. near Magdalena Rd	2.54	22	0.0333	2.46	15.4	767	647	300	103	255	11
26	Calabazas Ck. @ Wilcox School	13.97	22	0.0096	9.64	566.5	3740	3410	2190	1100	244	11
1	Penitencia Ck. @ Piedmont Rd.	22.42	21	0.028	12.61	836.5	3950	3130	1080	226	140	7
11164500	SAN FRANCISQUITO C AT STANFORD	37.4	32	0.0178	11.88	530.7	8360	7620	4480	1560	204	6
11172100	U. PENITENCIA CREEK AT SAN JOSE	21.5	22	0.0253	11.63	380.9	3720	3330	1680	405	155	7
31	*Calabazas Ck. @ Rainbow Dr.*	*4.49*	*28*	*0.02*	*5*	*79.5*	*3440*	*2880*	*1210*	*321*	*641*	*23*
24	San Tomas Ck. above William Rd.	15.98	25	0.0149	24.2	826.7	4400	3970	2410	1120	248	10
30	Wildcat Ck. @ SPRR near Quito Rd.	4.08	29	0.0278	4.55	67.1	1130	1000	576	257	245	8
29	San Tomas Ck. @ SPRR nr. Wilcox School	3.57	35	0.0696	5.3	72.1	1230	1070	538	177	300	8
73	Canoas Ck. @ Almaden Expwy	18.52	16	0.0017	10.76	1620.6	1380	1220	743	403	66	4
51	Ross Ck. @ Cherry Ave	9.77	21	0.0113	6.21	177	1580	1500	1120	629	154	7
11169500	SARATOGA CREEK AT SARATOGA	9.2	45	0.0622	5.23	50.1	4620	3730	1460	417	405	9
11169800	COYOTE CREEK NR GILROY	109	24	0.0196	27.02	1636.6	29300	25900	12300	2600	238	10
56	Las Animas Ck. @ O'Connell Ranch	37.15	23	0.0147	14.58	660.2	10600	8820	2980	359	237	10
11153900	EVES AB UVAS RES NR MORGAN HILL	21	41	0.0243	8.58	219.1	8260	7810	5530	2690	372	9
11154100	BODFISH CREEK NEAR GILROY	7.4	28	0.03	5.68	62	2300	2000	952	245	270	9
11152900	*CEDAR CREEK NEAR BELL STATION*	*12.8*	*22*	*0.028*	*8.33*	*203*	*6610*	*5840*	*2610*	*422*	*456*	*21*
65	Little Arthur Ck. Redwood Retreat Rd	9.29	35	0.0192	5.98	130.8	3090	2810	1630	562	302	9
11157500	TRES PINOS CR NEAR TRES PINOS	206	17	0.0156	31.1	3912	24500	18800	5370	783	91	6
11153000	PACHECO CREEK NR. DUNNEVILLE	146	16	0.0154	24.66	3525	25100	22500	11100	2230	154	10
11173550	ALAMEDA C TRIB2 NR WARM SPRINGS	0.47	20	0.2	1.89	3.6	80	66	26	5.77	140	7
11185150	*HORSE CR NR CLAYTON*	*0.33*	*22*	*0.313*	*1.16*	*1.33*	*168*	*137*	*46*	*6.13*	*415*	*19*
11313100	KELLOGG CREEK TRIB NEAR BYRON	1.07	14	0.062	2.27	11.21	181	152	55	7.74	142	10
11162470	PESCADERO CR TRIB NR LA HONDA	0.23	33	0.152	0.88	0.86	82	66	24	5.62	287	9
11162900	SHARON C NR MENLO PARK	0.38	24	0.012	0.9	3.38	119	112	83	51	295	12
11153050	PACHECO CR TRIB NR DUNNEVILLE	0.17	16	0.133	0.61	0.38	25	22	9.2	2.33	129	8
11153800	ALEC CANYON NEAR MORGAN HILL	0.91	45	0.234	1.52	2.16	587	511	248	72	562	12
11159770	*LAUREL CR NR LAUREL*	*0.94*	*45*	*0.054*	*1.59*	*5.71*	*827*	*724*	*350*	*93*	*770*	*17*
11160030	*S. LORENZO R TRIB NR BOULDER CR*	*0.21*	*50.5*	*0.062*	*0.81*	*1.24*	*259*	*211*	*76*	*14*	*1005*	*20*
11156450	WILLOW C TRIB NR SAN BENITO CA	1.27	16	0.053	2.39	20.45	250	159	23	1.98	125	8
11142600	REDWOOD GULCH NR JOLON	1.31	58	0.222	2.18	5.27	710	635	366	149	485	8
11148820	SAPAQUE CR TRIB AT BRYSON	0.77	52	0.051	1.93	9.58	462	322	60	5.22	418	8
11183700	LITTLE PINE C NR ALAMO	1.23	22	0.174	2.14	9.07	396	317	104	17	258	12
11162800	*REDWOOD CREEK AT REDWOOD CITY*	*1.79*	*26*	*0.16*	*2.94*	*6.98*	*718*	*664*	*443*	*221*	*371*	*14*
18	Golf Ck. near McAbee Rd.	1.87	24	0.051	1.89	4.96	642	587	360	147	314	13
11312950	MOUNT HOUSE C TRIB NR ALTAMONT	0.27	13	0.087	0.72	1.04	30	22	5.59	0.9	81	6

Table-2: Data Used in the Analyses of the 1-day Flood Volumes. (Remove Data When F =< 2)

Station Id	Station Names	A (SM)	M (IN)	Slope	Length	LLS	0.50%	1%	10%	50%	FACT OR
11160000	Soquel Cr. @ Soquel	40.2	36.95	0.0251	15.93	914	8730	7450	3270	794	5
11160500	San Lorenzo r. @ Big Trees	111	47	0.0075	19.7	905.4	25600	21300	8890	2320	4
11160060	Bear C r. @ Boulder	16	48.35	0.0288	8.26	248.7	3890	3070	1080	269	4
11162500	Pascadero Cr. Nr. Pascadero	45.9	40.36	0.0064	19.15	3717.5	7470	6320	2730	705	3
11160070	Boulder Cr. @ Boulder Cr.	11.3	55.02	0.0123	7.52	231.2	1980	1780	993	342	3
11160020	San Lorenzo R. Nr. Boulder Cr.	6.2	43.59	0.0943	4.22	28.6	1450	1180	419	79	4
11160300	Zayante Cr. @ Zayante	11.1	45.07	0.0282	6.95	121.5	3630	3060	1250	270	6
11159800	West Br.. Soquel Nr. Soquel	12.2	40	0.0265	9.17	251.9	3550	2970	1210	282	6
2000	Arroyo Seco Nr. Soledad	244	34.98	0.013	28.91	3265	23100	20200	10200	3410	2
11180500	Dry Creek @ Union City	9.40	20.22	.0231	5.06	132.50	987	830	305	44	4
11176400	Arroyo Valle Bl Lang Canyon	130	21.00	.0061	32.35	5177	12200	10300	3700	508	4
11337500	Marsh Cr. Nr. Byron	42.00	19	.0117	18.94	1276	4010	3290	1220	244	4
11164000	Matadero Cr.@ Palo Alto	7.3	24.67	.015	6.25	164.3	661	568	267	78	3
11161500	Branciforte @ Santa Cruz	17.3	27	0.0205	8.37	392	4730	4030	1810	497	9
11159690	Aptos C. Nr. Aptos	10.2	33.92	0.0442	7.46	130.9	2470	2060	795	156	6
11159150	Corralitos Cr. Nr. Corralitos	10.6	35	0.0441	5.64	83.6	1780	1550	732	187	4
11159700	Aptos Cr. @ Aptos	12.3	33.5	0.0258	9.36	242	1870	1580	647	140	4
11159200	Corralitos @ Freedom	27.8	30.65	0.0148	11.53	807.5	3310	2830	1270	320	3
11152600	Gabilan Cr. Nr. Salinas	36.7	16.96	0.0325	13.22	319.7	600	540	284	74	1
111 63500	Los Trancos @ Stanford	7.5	32	0.0284	7.01	145.8	1210	981	340	61	4
111 73200	Arroyo Hondo Nr. San Jose	77.1	25	0.009	25.76	3239	6550	6010	3570	1200	3
ID 64	Berryessa C. Above Calaveras Rd.	15.12	16.77	0.0551	8.75	183.4	467	424	264	122	2
ID 74	Sunnyvale East @ Bayshore	6.19	15.41	0.0081	5.78	176.6	195	178	118	67	2
ID 33	Hale Cr. Nr. Magdalena Rd	2.54	22.25	0.0333	2.46	15.4	208	180	89	28	3
ID 32	Permanente Cr.@ Berry Ave	8.4	24.99	0.0505	7.01	178.8	622	484	156	32	2
26	Calabazas Cr. @ Wilcox School	13.97	21.62	0.0096	9.64	566.5	1220	1060	527	170	4
1	Penitencia Cr. @ Piedmont Rd.	22.42	21.41	0.028	12.61	836.5	1400	1100	377	91	2
11164500	San Francisquito Cr. @ Stanford U.	37.4	32.36	0.0178	11.88	530.7	4370	3850	1920	542	3
11172100	Upper Penitencia Cr. @ San Jose	21.5	21.7	0.0253	11.63	380.9	778	712	416	135	2
31	Calabazas Cr. @ Rainbow Dr.	4.49	28.07	0.0204	5	79.5	606	523	250	76	4
24	San Tomas Cr. A William Rd.	15.98	25.07	0.0149	24.2	826.7	1270	1140	660	274	3
30	Wildcat Cr. @ SPRR Nr. Quito Rd.	4.08	29.35	0.0278	4.55	67.1	530	452	216	74	4
29	San Tomas @ SPRR Nr Wilcox School	3.57	35.48	0.0696	5.3	72.1	582	492	213	55	4
73	Canoas Cr. @ Almaden Exprswy	18.52	16.25	0.0017	10.76	1620.6	511	458	280	141	2
51	Ross Cr. @ Cherry	9.77	20.79	0.0113	6.21	177	706	610	316	126	3
11169500	Saratoga Cr. @ Saratoga	9.2	44.89	0.0622	5.23	50.1	1420	1210	558	171	3
11169800	Coyote cr. Nr. Gilroy	109	23.76	0.0196	27.02	1636.6	12600	11200	5370	1150	4
56	Las Animas @ O'Connell Ranch	37.15	23.19	0.0147	14.58	660.2	5540	4490	1340	127	5
57	Packwood Cr. @ Jackson Ranch	10.05	24.7	0.0206	6.63	157.5	536	424	126	16	2
11153900	Uvas Cr above Uvas Rsvr.	21	41.2	0.0243	8.58	219.1	5040	4440	2370	856	5
11154100	Bodfish Cr. Nr. Gilroy	7.4	28.46	0.03	5.68	62	819	711	330	81	3
11152900	Cedar Cr. Nr. Bell St.	12.8	22	0.0278	8.33	203	1530	1350	635	131	5
65	Little Arthur A2 Redwood Retreat Rd.	9.29	34.52	0.0192	5.98	130.8	1440	1290	687	202	4
11157500	Tres Pinos Cr. Nr. Tres Pinos	206	16.5	0.0156	31.1	3912	12400	9340	2310	242	3

5 REGRESSION ANALYSIS

The goal of this study is to develop equations for estimating flood quantiles for ungaged watershed by using the basin characteristics. The step-wise multiple linear regression model is employed and presented in the following form:

$$Y_t = a_t + \sum (b_{t,,l} * Z_l)$$

Where:

X_t = *Transformed dependent variable (quantile) for return-period t.*
Z_l = *Transformed independent variables (basin parameters l = 1,2,3...)*
a_t and $b_{t,l}$ *are the regression constant and coefficients for return period t and variable l.*

The Corps of Engineers Multiple Linear Regression Program (MLRP)(8) is used to develop equations for the quantiles of instantaneous peak flows and the 1-day volumes.
Note: The 24-hr flood quantiles were conservatively obtained by multiplying the 1-day quantiles by 1.15.

As shown in **Tables 1** and **2** below, the basin parameters are defined as follows:

A is the drainage area upstream of the gage location measured in square miles.
P is the mean annual precipitation in inches averaged over the drainage area A
L is the longest path of water in miles
S is the average slope of the longest path of water measured at quarter points
LLS is the basin factor calculated as follows:

$$LLS = L * Lca / S^{0.5}$$

Where:

Lca is the length of the main stem of the watercourse to a point that is closest to the center of gravity of the watershed.

The MLRP is a step-wise program that has the ability of automatic deletion of independent variables for an optimum choice of the best model. In addition, the program has the ability to combine and/or transform variables as needed. The transformation tends to make the variables normally distributed with increased auto and cross correlation of variables among themselves and among stations. The normally distributed regression model will explain most of the information about the various statistics (mean, variance and covariance).

In this program four types of transformations were tried:

- No transformation,
- Square root ($Z= X^{0.5}$),
- Log transformation ($Z=Log10\ X$)
- Reciprocal ($Z=1/X$).

The log transform was applied to the quantiles, the areas and the mean annual precipitations, while the square root and reciprocal transforms were used for others variables.

6 *RESULTS*

The following **Table-3** shows the results of the final choice of the regression equations **(9V1Dx)** and **(9S-LQx)** in the linear form; the same equations are shown in the summary in the multiplicative form. **Appendix-2** includes the MLRP program outputs for the final equations. The finally chosen regression equations comply, mainly, with the criterion of maximum determination and minimum standard error. At times, this criterion was relaxed to accommodate the practicability and increased degrees of freedom of using two independent variables rather than three or more. However, as shown in **Table-3** below, this relaxation was limited to the conditions where the differences in the determination coefficients are extremely small.

Table-3 also shows that the Areas ***(A)*** and the Mean Annual Precipitations ***(P)*** are the two independent variables that explain most of the variance about the dependent variables. These independent variables are so physically related to the dependent variables that approximate a cause and effect relationship.

Of major concern is the implementation of the chosen model to develop uniformly (monotonically) increasing or decreasing frequency curves. To satisfy this issue those equations are tested on rural drainage areas from Llagas Creek in the southern part of Santa Clara County and presented in **Appendix 3.** The curves proved that the probabilistic flood curves are monotonic and equally applicable across various probabilities of occurrence.

Table 3 Final Regression Equations.

				Coefficients OF Logs								
File Name	**# Years**	**Flow**	**Constant**	**A**	**P**	**L**	**S**	**LLS**	**R^2**	**SE**	**Notes 1**	**Notes 2**
Small and Large Peaks												
9S-LQ200	42	Q.5%	1.22	1.02	0.965			-0.005	0.965	0.142		
9S-LQ200	42	Q.5%	1.151	0.946	1.005				0.963	0.146	(LOGA,P). (SQRTS,L,LLS)	MA
9S-LQ100	42	Q1%	1.114	1.03	0.99			-0.005	0.966	0.141		
9S-LQ100	42	Q1%	1.05	0.954	1.03				0.964	0.145	(LOGA,P). (SQRTS,L,LLS)	MA
9S-LQ10	42	Q10%	0.541	1.063	1.135			-0.005	0.948	0.183		
9S-LQ10	42	Q10%	0.475	0.988	1.173				0.947	0.185	(LOGA,P). (SQRTS,L,LLS)	MA
9S-LQ2	42	Q50%	-0.359	0.908	1.519		-0.851		0.87	0.311		
9S-LQ2	42	Q50%	-0.491	1	1.437				0.866	0.316	(LOGA,P). (SQRTS,L,LLS)	MA
Small and Large Volumes												
9V1D200	37	V.5%	0.415	0.967	1.188				0.921	0.139		BF, MA
9V1D100	37	V1%	0.353	0.964	1.187				0.927	0.133		BF, MA
9V1D10	37	V10%	-0.048	0.933	1.244				0.932	0.125		BF, MA
9V1D2	37	V50%	-0.958	0.861	1.51				0.83	0.197		MA

Where: BF = Best Fit, MA = Most Applicable

The following **Table-4** shows the results of all runs executed in this study using as many groupings of data as possible. In addition, an attempt was made to regress the statistics (means and standard deviations) of data. This option was dropped because of the added uncertainty in the choice of the distribution factors and the lack of correlations between the standard deviation and other variable.

It is shown that the determination coefficients of the means are between 0.2 and 0.6, hardly acceptable for any projection. For the standard deviation the determination was between 0.1 and 0.2, a very poor determination indeed.

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Table-4. Results of the Regional Regression study

SUMMARY OF REG REG EQUATIONS

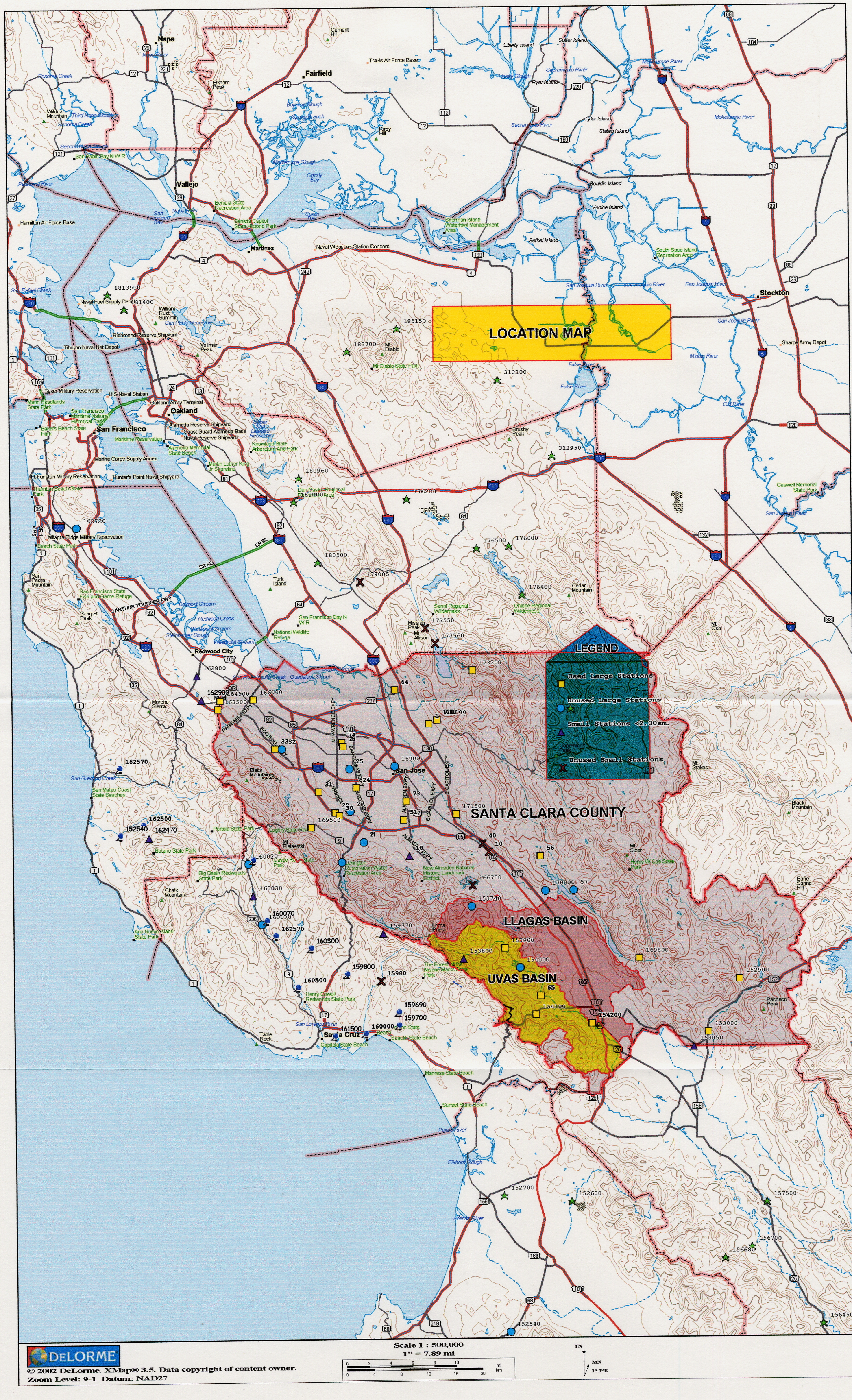
				Coefficients OF Logs								
File Name	**# Years**	**Flow**	**Constant**	**A**	**P**	**L**	**S**	**LLS**	**R^2**	**SE**	**Notes**	**Rate**
LARGE PEAKS												
ALLMEANS	76	LOG M	-1.011	0.8014	1.821				0.619	0.399	ALL DATA M NO TRANS	
ALL1MEAN	58	LOG M	-1.555	0.911	2.117				0.573	0.401	A<50SM, CORRECT MAP	
SCMEANS	28	LOGM	0.6806	0.6949	0.7834				0.588	0.305	ALL DATA IN SCC	
SC1MEANS	24	LOGM	0.7285	0.6617	0.9549				0.223	0.322	SAME AS 3 A<50SM	
SC2MEANS	24	LOGLOG M	0.0973	0.1066				0.166	0.209	0.057	SAME AS 4 LOGLOG TRANS	
SC-SD	28	LOGSD	0.651	0.448				-0.261	0.146	0.197	ALL SC DATA	
SC-LOGSD	28	LOGLOGSD	-0.1074	0.521				-0.334	0.166	0.205	SAME AS 6 WITH LOGLOG	
SC1LOGSD	24	LOGLOGSD	-0.0559	0.74				-0.454	0.244	0.2	SAME AS 7 WITH A<50 SM	
2REGQ1	76	LOGQ1	0.5876	0.9168	1.281				0.774	0.291	ALL DATA, LOG FLOWS	
SC2REGQ1	35	LOGQ1	0.534	0.805	1.424				0.754	0.258	SAME AS 9 LESS BAD DATA OTHERS	
NEWSC2Q1	28	LOGQ1	1.203	0.854	0.9144				0.839	0.187	SCC DATA	
NEWSQ10	28	LOG10	0.9833	0.842	0.8735				0.825	0.193	SAME AS 11 FOR 10% FLOW	
3WEND6Q1	28	Q1%	1.466	1.101	0.673			-0.008	0.884	0.169	SQRT S, LLS, REMOVE 32,57	
3WEND6Q1	28	Q1%	1.353	0.845	0.844				0.872	0.177		MA
3WEND7Q1	28	Q1%	1.774	0.858	0.575		-0.0008		0.898	0.158	1/S, 1/LLS	best fit
		Q1%	2.605	0.852			0.0011		0.885	1.68		
3WEND8Q1	28	Q1%	1.327	0.885	0.667		1.225		0.88	0.171	SQRT S, 1/LLS	
		Q1%	1.327	0.842	0.864				0.874	0.176		
3WEN7Q10	27	Q10%	1.538	0.857	0.534		-0.0006		0.892	0.155	1/S	best fit
		Q10%	2.3	0.864			-0.0009		0.881	0.163		
3WEN8Q10	27	Q10%	1.182	0.81	0.802			-1.78	0.874	0.168	SQRT S, 1/LLS	
3WEN8Q10	27	Q10%	1.165	0.835	0.782				0.877	0.165		MA
LARGE VOLUMES												
6V1D200	28	V.5%	-0.165	1.005	1.522				0.927	0.15		MA
6V1D100	28	V1%	-0.23	1	1.528				0.934	0.141		MA
6V1D10	28	V10%	-0.5	0.944	1.531				0.945	0.121		MA
6V1D2	28	V50%	-0.867	0.809	1.505				0.802	0.216		MA
7V1D100	22	V1%	0.528	1.118	0.987			-0.004	0.973	0.083	SQRT LLS	BEST FIT
	22	V1%	0.435	1.003	1.091				0.971	0.086		MA
9V1D200	37	V.5%	0.415	0.967	1.188				0.921	0.139		BF, MA
9V1D100	37	V1%	0.353	0.964	1.187				0.927	0.133		BF, MA
9V1D10	37	V10%	-0.048	0.933	1.244				0.932	0.125		BF, MA
9V1D2	37	V50%	-0.958	0.861	1.51				0.83	0.197		MA
SMALL PEAKS (LT 2 SQ MI)												
2SMPK200	16	Q.5%	0.806	1.011	1.22				0.913	0.143		A
2SMPK100	16	1%	0.668	1.018	1.259				0.902	0.156		A
2SMPK100	16	Q10%	-0.0015	1.073	1.446				0.759	0.293		A
2SMPK2	16	Q50%	1	2.348	1.207		-0.503		0.717	0.4		?
2SMPK2	16	Q50%	3.018	2.695			-0.612		0.614	0.466		?
2SMPK2	16	Q50%	1.45	1.279					0.312	0.622		NA
SMALL AND LARGE PEAKS												
1SM-LGQ1	44	Q1%	0.958	1.031	1.063			-0.006	0.96	0.164	SQRT S & LLS	BEST FIT
	44	Q1%	0.849	0.921	1.13				0.956	0.172	SMALL A, REDUCED Q'S	A
2SM-LGQ1	41	Q1%	1.001	1.072	1.01			-0.007	0.967	0.148	SAME	BF
	41	Q1%	0.839	0.935	1.115				0.962	0.159	SAME	MA

3S-LQ200	41	Q.5%	1.107	0.98	1.015			-0.003	0.957	0.157	SQ RT LLS	B.F.
3S-LQ200	41	Q.5%	1.059	0.917	1.044				0.956	0.159	SAME	M.A.
3S-LQ100	41	Q1%	1.018	1.002	1.027			-0.004	0.957	0.158		B.F.
3S-LQ100	41	Q1%	0.96	0.926	1.062				0.956	0.161		M.A.
3S-LQ10	41	Q10%	0.491	1.095	1.138			-0.006	0.922	0.23		B.F.
3S-LQ10	41	Q10%	0.407	0.986	1.188				0.92	0.235		M.A.
3S-LQ2	41	Q50%	-0.193	1.271	1.234			-0.015	0.81	0.394		B.F.
3S-LQ2	41	Q50%	-0.398	1.001	1.350				0.799	0.414		M.A.
LESS THAN 5 SQ MI												
1LT5Q1	18	Q1%	0.967	1.242	1.078			-0.019	0.946	0.138	SQRT S &LLS	
1LT5Q1	18	Q1%	0.865	1.142	1.104				0.947	0.136	SAME	BF & MA
1LTQ200	18	0.50%	1.343	1.345	1.048		-0.222		0.955	0.123	SQRT S	B.F
1LTQ200	18	0.50%	1.009	1.13	1.059				0.953	0.125		M.A.
1LT5Q10	18	10%	0.451	1.46	1.235			-0.073	0.845	0.266	SQ RT S & LLS	BF
1LT5Q10	18	10%	0.201	1.215	1.3				0.844	0.267		MA
1LT5Q2	18	50%	-0.35	1.712	1.451			-0.076	0.668	0.478		
1LT5Q2	18	5%	-0.75	1.319	1.555				0.671	0.476		BF, MA
MORE THAN 9 SQ MI												
1MT9Q200	18	Q.5%	1.932	0.819	0.417		1.159		0.86	0.138	S^0.5	BF
1MT9Q200	18	Q.5%	2.086	0.772	0.468				0.852	0.141		MA
1MT9Q100	18	Q100%	1.923	0.944	0.46			-0.005	0.853	0.138	LLS^0.5	BF
1MT9Q100	18	Q100%	1.967	0.762	0.523				0.853	0.138		MA
1MT9Q100	18	Q10%	1.128	0.864	0.856			-0.002	0.73	0.201	LLS^0.5	
1MT9Q100	18	Q10%	1.149	0.775	0.887				0.746	0.195		BF, MA
1MT9Q2	18	Q50%	0.261		1.541	0.199	-1.532		0.43	0.29	S^0.5	NA.
SMALLER THAN 9 SQ MI												
1ST9Q200	23	0.50%	1.002	1.041	1.133			-0.026	0.903	1.57		BF
1ST9Q200	23	0.50%	0.804	0.865	1.202				0.896	0.162		MA
1ST9Q100	23	1%	0.912	1.083	1.147			-0.023	0.907	0.162		BF
1ST9Q100	23	1%	0.733	0.927	1.21				0.903	0.166		MA
1STQ9Q10	23	10%	0.381	1.198	1.321		-0.383		0.848	0.28		
1STQ9Q10	23	10%	0.316	1.249	1.287				0.852	0.276		BF, MA
1SR9Q2	23	50%	-0.189	1.651	1.487		-0.909		0.763	0.512		
1SR9Q2	23	50%	-344	1.77	1.406				0.764	0.511		BF,MA
SAME AS 3 + SANTA CRUZ COUNTY												
4S-LQ100	57	Q1%	0.995	1.004	1.047			-0.004	0.951	0.164		
	57	Q1%	0.914	0.925	1.1				0.948	0.16	SAME AS 3S-LQxx	
SAME AS 4 REMOVE OUTLYING AREAS												
5S-LQ100	49	Q1%	1.002	1.005	1.042			-0.004	0.94	0.165		
	49	Q1%	0.965	0.929	1.063				0.938	0.168	SAME AS 3S-LQxx	
SAME AS 5 +STA. # 48820 REMOVE DATA FACTOR=<5												
6S-LQ100	50	Q1%	1	1	1.04			-0.004	0.934	0.173		
	50	Q1%	0.967	0.93	1.06				0.933	0.173	SAME AS 3S-LQxx	
SAME AS 6 ALL DATA + S.CRUZ REMOVE F=<6												
7S-LQ100	44	Q1%	0.919	1.035	1.105			-0.005	0.963	0.146		
	44	Q1%	0.859	0.952	1.14				0.96	0.152		
SAME AS 5 ALL DATA + S.CRUZ REMOVE =<7												
8S-LQ100	43	Q1%	1.173	1.04	0.944			-0.005	0.966	0.142		
	43	Q1%	1.11	0.962	0.978				0.963	0.146		
SAME AS 8 REMOVE 48820 (OUT OF AREA)												
THE FINAL EQUATIONS												
9S-LQ200	42	Q.5%	1.22	1.02	0.965			-0.005	0.965	0.142		
9S-LQ200	42	Q.5%	1.151	0.946	1.005				0.963	0.146	(LOGA,P). (SQRTS,L,LLS)	MA
9S-LQ100	42	Q1%	1.114	1.03	0.99			-0.005	0.966	0.141		
9S-LQ100	42	Q1%	1.05	0.954	1.03				0.964	0.145	(LOGA,P). (SQRTS,L,LLS)	MA
9S-LQ10	42	Q10%	0.541	1.063	1.135			-0.005	0.948	0.183		
9S-LQ10	42	Q10%	0.475	0.988	1.173				0.947	0.185	(LOGA,P). (SQRTS,L,LLS)	MA
9S-LQ2	42	Q50%	-0.359	0.908	1.519		-0.851		0.87	0.311		
9S-LQ2	42	Q50%	-0.491	1	1.437				0.866	0.316	(LOGA,P). (SQRTS,L,LLS)	MA

8 REFERENCES

1. Saah, Talley, Sanchez, Watson, *Development of Regional Regression Equations for solution of Certain Hydrologic Problems In and Adjacent to Santa Clara County*, San Jose, CA, SCVWD, November 1976
2. Myron Fiering, U*se Of Correlation to Improve estimates of the Mean and Variance,* Statistical Studies in Hydrology.
3. US Water Resources Council Bulletin 17, *A Draft Report For Determining Design Flood Flow Frequency*, 1974.
4. Saah, A. W. Chang, J. Wang and G.Q. Tabios, *Flood Quantiles Estimation Based on Regional Analysis for Santa Clara County and Vicinity*, San Jose CA. SCVWD, May 1996
5. Water Resources Council, USGS, *Guidelines for Determining Flood Flow Frequency, Bulletin #17B*, Reston Virginia 1982
6. Saah, A. and C. Nahn, *Hydrology Open File Report (Mean Annual Precipitation Map)*, San Jose CA. SCVWD, October 1986
7. US Army Corps of Engineers, *Flood Flow Frequency Computer program (FFA)*, HEC 1982
8. US Army Corps of Engineers, *Multiple Linear Regression program*, HEC 704-G1-L2020
9. Saah, A., B.S. Jaber, G.Q. Tabios, and W. Chang, *Precipitation Depth-Duration-Frequency Analysis: Time-Duration-Specific Quantile Estimation*, San Jose, CA, SCVWD, May 1996
10. Saah, A., G.Q. Tabios, W. Chang and B.S. Jaber, *Precipitation-Depth-Duration-Frequency Analysis and Modeling for Santa Clara County and Vicinity*, San Jose, CA. SCVWD. 1996.
11. Saah, A., G.Q. Tabios, and B.S. Jaber, *Precipitation Skew-- Regional Analysis*, San Jose CA. SCVWD 1996
12. Wang, J. et al., *Hydrology Procedures, SCVWD*, San Jose CA. 1998
13. US Army Corps of Engineers, HEC, Leo Beard, *Statistical Methods in Hydrology*, 1963

9 APPENDIX 1: STUDY AREA AND LOCATION OF STREAMFLOW GAGING STATIONS



DELORME

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Zoom Level: 9-1 Datum: NAD27

10 APPENDIX 2: OUTPUTS OF THE MULTIPLE LINREAR REGRESSION PROGRAM

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1*********************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
   REVISED            JAN 1983
 *********************************


  9S-LQ2 REG REG, HISTORICAL 50% FLOWS IN SANTA CLARA + SANTA CRUZ+OTHER SMALL A
  DATA FROM 1996 STUDY UPDATED BY WENDY C IN 2002,INCLUDE ALL SMALL AREAS<2SQMI
  DATA FROM SMALL + LRGE DA. REMOVE fACTOR<=7, REMOVE 48820 (OUT OF AREA)


   NVAL    NCOMB    IPRNT    IFRMT    IDELE     DELTA
      9        0        0        0        0     .0000

                                              + + + + ANALYSIS NO  1 + + + +

                                              DEPENDENT VARIABLE --       2YR


   IDEP      .......TRANSFORMATION CODES........    NOBR     IRES    IFORC
      9      3 3 2 2 2 0 0 0 3 0 0 0 0 0 0 0 0 0      0        0        0


  VARIABLE     TRANSFORMATION
      AREA        COMMON LOG
       MAP        COMMON LOG
     SLOPE       SQUARE ROOT
    LENGTH       SQUARE ROOT
       LLS       SQUARE ROOT
     200YR          NOT USED
     100YR          NOT USED
      10YR          NOT USED
       2YR        COMMON LOG


 INPUT DATA

 OBS NO   OBS ID         AREA          MAP       SLOPE      LENGTH         LLS          2YR
      1     6000       40.200       37.000        .025      15.930     914.000     2420.000
      2     6050      111.000       47.000        .007      19.700     905.000     5460.000
      3     6006       16.000       48.000        .029       8.280     248.700     1110.000
      4     6250       45.900       40.000        .006      19.150    3717.000     1890.000
      5     6002        6.200       44.000        .094       4.220      29.000      220.000
      6     6030       11.100       45.000        .028       6.950     121.000      895.000
      7     5980       12.200       40.000        .026       9.170     252.000     1040.000
      8     6150       17.300       27.000        .021       8.370     392.000     1610.000
      9     5969       10.200       34.000        .044       7.460     131.000      374.000
     10     5915       10.600       35.000        .044       5.640      84.000      513.000
     11     5970       12.300       34.000        .026       9.360     242.000      427.000
     12     5940        7.100       26.000        .010       8.900     241.000      288.000
     13     5920       27.800       31.000        .015      11.530     807.000      966.000
     14     6600        7.300       25.000        .015       6.250     164.300      385.000
     15     64         15.120       17.000        .055       8.750     183.400      771.000
     16     33          2.540       22.000        .033       2.460      15.400      103.000
     17     26         13.970       22.000        .010       9.640     566.500     1100.000
     18     31          4.490       28.000        .020       5.000      79.500      321.000
   19     24        15.980     25.000        .015     24.200    826.700   1120.000
   20     30         4.080     29.000        .028      4.550     67.100    257.000
   21     29         3.570     35.000        .070      5.300     72.100    177.000
   22     6950       9.200     45.000        .062      5.230     50.100    417.000
   23     56        37.150     23.000        .015     14.580    660.200    359.000
   24     5390      21.000     41.000        .024      8.580    219.100   2690.000
   25     5410       7.400     28.000        .030      5.680     62.000    245.000
   26     5290      12.800     22.000        .028      8.330    203.000    422.000
   27     65         9.290     34.000        .019      5.980    130.800    562.000
   28     5300     146.000     24.000        .015     24.660   3525.000   2230.000
   29     6980     109.000     22.000        .020     27.000   1637.000   2600.000
   30     8515        .330     22.000        .313      1.160      1.330      6.000
   31     3131       1.070     14.000        .062      2.270     11.210      7.740
   32     6247        .230     33.000        .152       .880       .860      5.620
   33     6290        .380     24.000        .012       .900      3.380     51.000
   34     5305        .170     16.000        .133       .610       .380      2.330
   35     5380        .910     45.000        .234      1.520      2.160     72.000
   36     5977        .940     45.000        .054      1.590      5.710     93.000
   37     6003        .210     51.000        .062       .810      1.240     14.000
   38     5645       1.270     16.000        .053      2.390     20.450      2.000
   39     4260       1.310     58.000        .222      2.180      5.270    149.000
   40     8370       1.230     22.000        .174      2.140      9.070     17.000
   41     6280       1.790     26.000        .160      2.940      6.980    221.000
   42     18         1.870     24.000        .051      1.890      4.960    147.000

STATISTICS OF DATA

BASED ON    42 OBSERVATIONS
                                                      STANDARD
     VARIABLE           AVERAGE          VARIANCE     DEVIATION

        AREA              .7505            .5589         .7476
         MAP             1.4741            .0229         .1512
       SLOPE              .2157            .0137         .1171
      LENGTH             2.5165           1.3696        1.1703
         LLS            13.9564         205.8080       14.3460
         2YR             2.3779            .7437         .8624     DEPENDENT VARIABLE

SIMPLE CORRELATION COEFFICIENTS

  VARIABLE       AREA        MAP      SLOPE     LENGTH        LLS        2YR
      AREA     1.0000      .0000    -.6681      .9310      .8056      .8972
       MAP      .0000     1.0000     .0000      .0000      .0000      .3345
     SLOPE    -.6681      .0000     1.0000     -.6386     -.5709     -.6286
    LENGTH     .9310      .0000     -.6386     1.0000      .8963      .8070
       LLS     .8056      .0000     -.5709      .8963     1.0000      .6641
       2YR     .8972      .3345     -.6286      .8070      .6641     1.0000

     INDEPENDENT           REGRESSION          PARTIAL
      VARIABLE             COEFFICIENT       DETERMINATION
                                              COEFFICIENT

          AREA               .941987             .3662
           MAP              1.492480             .3326
         SLOPE              -.892974             .0361
        LENGTH               .069866             .0000
           LLS              -.009013             .0079
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                                                        STANDARD
    REGRESSION           R              R BAR           ERROR OF
     CONSTANT          SQUARE           SQUARE          ESTIMATE
      -.386579         .8840            .8679             .3135

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                                          VARIABLE DELETED IS    LENGTH


    INDEPENDENT          REGRESSION           PARTIAL
     VARIABLE            COEFFICIENT        DETERMINATION
                                             COEFFICIENT

         AREA             1.008932             .6233
          MAP             1.468563             .3304
        SLOPE             -.889926             .0361
          LLS             -.006698             .0083

                                                        STANDARD
    REGRESSION           R              R BAR           ERROR OF
     CONSTANT          SQUARE           SQUARE          ESTIMATE
      -.258715         .8834            .8708             .3100

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                                          VARIABLE DELETED IS       LLS


    INDEPENDENT          REGRESSION           PARTIAL
     VARIABLE            COEFFICIENT        DETERMINATION
                                             COEFFICIENT

         AREA              .907511             .7186
          MAP             1.518827             .3427
        SLOPE             -.851002             .0300

                                                        STANDARD
    REGRESSION           R              R BAR           ERROR OF
     CONSTANT          SQUARE           SQUARE          ESTIMATE
      -.358573         .8792            .8697             .3113

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                                          VARIABLE DELETED IS     SLOPE


    INDEPENDENT          REGRESSION           PARTIAL
     VARIABLE            COEFFICIENT        DETERMINATION
                                             COEFFICIENT

         AREA             1.000058             .8487
          MAP             1.437208             .3110
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                                                      STANDARD
  REGRESSION           R             R BAR            ERROR OF
   CONSTANT          SQUARE          SQUARE           ESTIMATE
    -.491294         .8722           .8657              .3161

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                                              VARIABLE DELETED IS      MAP


  INDEPENDENT          REGRESSION           PARTIAL
   VARIABLE           COEFFICIENT        DETERMINATION
                                          COEFFICIENT

       AREA             1.038089             .8050

                                                      STANDARD
  REGRESSION           R             R BAR            ERROR OF
   CONSTANT          SQUARE          SQUARE           ESTIMATE
    1.598807         .8098           .8050              .3808

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1********************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
   REVISED            JAN 1983
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  9S-LQ10 REG REG, HISTORICAL 10% FLOWS IN SANTA CLARA + SANTA CRUZ+OTHER SMALL
  DATA FROM 1996 STUDY UPDATED BY WENDY C IN 2002,INCLUDE ALL SMALL AREAS<2SQMI
  DATA FROM SMALL + LRGE DA. REMOVE fACTOR<=7, REMOVE 48820 (OUT OF AREA)


   NVAL    NCOMB    IPRNT    IFRMT    IDELE      DELTA
      9        0        0        0        0      .0000

                                              + + + + ANALYSIS NO  1 + + + +

                                              DEPENDENT VARIABLE --      10YR


   IDEP      .......TRANSFORMATION CODES........     NOBR     IRES    IFORC
      9      0 3 3 2 2 2 0 0 3 0 0 0 0 0 0 0 0 0        0        0        0


  VARIABLE     TRANSFORMATION
    1%FLOW          NOT USED
      AREA        COMMON LOG
       MAP        COMMON LOG
     SLOPE       SQUARE ROOT
    LENGTH       SQUARE ROOT
       LLS       SQUARE ROOT
    200YR           NOT USED
     100YR          NOT USED
      10YR        COMMON LOG


 INPUT DATA

 OBS NO   OBS ID        AREA         MAP        SLOPE      LENGTH         LLS       10YR
      1     6000      40.200      37.000         .025      15.930     914.000   7440.000
      2     6050     111.000      47.000         .007      19.700     905.000  18500.000
      3     6006      16.000      48.000         .029       8.280     248.700   3600.000
      4     6250      45.900      40.000         .006      19.150    3717.000   6850.000
      5     6002       6.200      44.000         .094       4.220      29.000   1030.000
      6     6030      11.100      45.000         .028       6.950     121.000   4190.000
      7     5980      12.200      40.000         .026       9.170     252.000   3850.000
      8     6150      17.300      27.000         .021       8.370     392.000   4350.000
      9     5969      10.200      34.000         .044       7.460     131.000   2490.000
     10     5915      10.600      35.000         .044       5.640      84.000   1840.000
     11     5970      12.300      34.000         .026       9.360     242.000   1860.000
     12     5940       7.100      26.000         .010       8.900     241.000    847.000
     13     5920      27.800      31.000         .015      11.530     807.000   3550.000
     14     6600       7.300      25.000         .015       6.250     164.300   1070.000
     15       64      15.120      17.000         .055       8.750     183.400   2200.000
     16       33       2.540      22.000         .033       2.460      15.400    300.000
     17       26      13.970      22.000         .010       9.640     566.500   2190.000
     18       31       4.490      28.000         .020       5.000      79.500   1210.000
 19    24       15.980     25.000        .015     24.200    826.700   2410.000
 20    30        4.080     29.000        .028      4.550     67.100    576.000
 21    29        3.570     35.000        .070      5.300     72.100    538.000
 22    6950      9.200     45.000        .062      5.230     50.100   1460.000
 23    56       37.150     23.000        .015     14.580    660.200   2980.000
 24    5390     21.000     41.000        .024      8.580    219.100   5530.000
 25    5410      7.400     28.000        .030      5.680     62.000    952.000
 26    5290     12.800     22.000        .028      8.330    203.000   2610.000
 27    65        9.290     34.000        .019      5.980    130.800   1630.000
 28    5300    146.000     24.000        .015     24.660   3525.000  11100.000
 29    6980    109.000     22.000        .020     27.000   1637.000  12300.000
 30    8515       .330     22.000        .313      1.160      1.330     46.000
 31    3131      1.070     14.000        .062      2.270     11.210     55.000
 32    6247       .230     33.000        .152       .880       .860     24.000
 33    6290       .380     24.000        .012       .900      3.380     83.000
 34    5305       .170     16.000        .133       .610       .380      9.200
 35    5380       .910     45.000        .234      1.520      2.160    248.000
 36    5977       .940     45.000        .054      1.590      5.710    350.000
 37    6003       .210     51.000        .062       .810      1.240     76.000
 38    5645      1.270     16.000        .053      2.390     20.450     23.000
 39    4260      1.310     58.000        .222      2.180      5.270    366.000
 40    8370      1.230     22.000        .174      2.140      9.070    104.000
 41    6280      1.790     26.000        .160      2.940      6.980    433.000
 42    18        1.870     24.000        .051      1.890      4.960    360.000


STATISTICS OF DATA

BASED ON   42 OBSERVATIONS
                                                        STANDARD
   VARIABLE          AVERAGE          VARIANCE          DEVIATION

      AREA             .7505             .5589             .7476
       MAP            1.4741             .0229             .1512
     SLOPE             .2157             .0137             .1171
    LENGTH            2.5165            1.3696            1.1703
       LLS           13.9564          205.8080           14.3460
      10YR            2.9450             .6438             .8024      DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

 VARIABLE     AREA       MAP      SLOPE     LENGTH       LLS      10YR
     AREA   1.0000     .0000    -.6681      .9310     .8056     .9480
      MAP    .0000    1.0000     .0000      .0000     .0000     .3074
    SLOPE   -.6681     .0000    1.0000     -.6386    -.5709    -.6281
   LENGTH    .9310     .0000    -.6386     1.0000     .8963     .8572
      LLS    .8056     .0000    -.5709      .8963    1.0000     .7146
     10YR    .9480     .3074    -.6281      .8572     .7146    1.0000


   INDEPENDENT           REGRESSION            PARTIAL
    VARIABLE             COEFFICIENT         DETERMINATION
                                              COEFFICIENT

        AREA               .990162              .6532
         MAP              1.178696              .4763
       SLOPE              -.329305              .0000
      LENGTH               .041669              .0000
         LLS              -.006316              .0216
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                                                    STANDARD
   REGRESSION           R             R BAR         ERROR OF
    CONSTANT          SQUARE          SQUARE        ESTIMATE
      .518612         .9531           .9466           .1854

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                                           VARIABLE DELETED IS   LENGTH


   INDEPENDENT        REGRESSION        PARTIAL
    VARIABLE          COEFFICIENT     DETERMINATION
                                       COEFFICIENT

         AREA           1.030088         .8328
          MAP           1.164431         .4758
        SLOPE           -.327488         .0000
          LLS           -.004935         .0267

                                                    STANDARD
   REGRESSION           R             R BAR         ERROR OF
    CONSTANT          SQUARE          SQUARE        ESTIMATE
      .594872         .9529           .9478           .1834
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                                           VARIABLE DELETED IS    SLOPE


   INDEPENDENT        REGRESSION        PARTIAL
    VARIABLE          COEFFICIENT     DETERMINATION
                                       COEFFICIENT

         AREA           1.062572         .8665
          MAP           1.134622         .4629
          LLS           -.004737         .0223

                                                    STANDARD
   REGRESSION           R             R BAR         ERROR OF
    CONSTANT          SQUARE          SQUARE        ESTIMATE
      .541018         .9517           .9478           .1832
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                                           VARIABLE DELETED IS      LLS


   INDEPENDENT        REGRESSION        PARTIAL
    VARIABLE          COEFFICIENT     DETERMINATION
                                       COEFFICIENT

         AREA            .987858         .9411
          MAP           1.172807         .4731
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                                                    STANDARD
    REGRESSION            R              R BAR      ERROR OF
     CONSTANT           SQUARE           SQUARE     ESTIMATE
       .474695          .9493            .9467        .1853

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                                           VARIABLE DELETED IS      MAP


    INDEPENDENT         REGRESSION           PARTIAL
      VARIABLE         COEFFICIENT        DETERMINATION
                                           COEFFICIENT

          AREA            1.018892            .8987

                                                    STANDARD
    REGRESSION            R              R BAR      ERROR OF
     CONSTANT           SQUARE           SQUARE     ESTIMATE
      2.180284          .9012            .8987        .2553

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1********************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
   REVISED            JAN 1983
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  9S-LQ100 REG REG, HISTORICAL 1% FLOWS IN SANTA CLARA + SANTA CRUZ+OTHER SMALL
  DATA FROM 1996 STUDY UPDATED BY WENDY C IN 2002,INCLUDE ALL SMALL AREAS<2SQMI
  DATA FROM SMALL + LRGE DA. REMOVE fACTOR<=7, REMOVE 48820 (OUT OF AREA)



   NVAL   NCOMB   IPRNT   IFRMT   IDELE     DELTA
      8       0       0       0       0     .0000

                                              + + + + ANALYSIS NO  1 + + + +

                                              DEPENDENT VARIABLE --     100YR


   IDEP      .......TRANSFORMATION CODES........     NOBR     IRES    IFORC
      8      0 3 3 2 2 2 0 3 0 0 0 0 0 0 0 0 0 0        0        0        0


  VARIABLE    TRANSFORMATION
    1%FLOW          NOT USED
      AREA        COMMON LOG
       MAP        COMMON LOG
     SLOPE       SQUARE ROOT
    LENGTH       SQUARE ROOT
       LLS       SQUARE ROOT
    200YR           NOT USED
     100YR        COMMON LOG


 INPUT DATA

 OBS NO  OBS ID        AREA         MAP       SLOPE      LENGTH         LLS      100YR
      1    6000      40.200      37.000        .025      15.930     914.000  13200.000
      2    6050     111.000      47.000        .007      19.700     905.000  39300.000
      3    6006      16.000      48.000        .029       8.280     248.700   7760.000
      4    6250      45.900      40.000        .006      19.150    3717.000  13900.000
      5    6002       6.200      44.000        .094       4.220      29.000   2540.000
      6    6030      11.100      45.000        .028       6.950     121.000   9780.000
      7    5980      12.200      40.000        .026       9.170     252.000   8270.000
      8    6150      17.300      27.000        .021       8.370     392.000   8310.000
      9    5969      10.200      34.000        .044       7.460     131.000   7510.000
     10    5915      10.600      35.000        .044       5.640      84.000   3720.000
     11    5970      12.300      34.000        .026       9.360     242.000   4160.000
     12    5940       7.100      26.000        .010       8.900     241.000   1710.000
     13    5920      27.800      31.000        .015      11.530     807.000   7570.000
     14    6600       7.300      25.000        .015       6.250     164.300   1930.000
     15      64      15.120      17.000        .055       8.750     183.400   4060.000
     16      33       2.540      22.000        .033       2.460      15.400    647.000
     17      26      13.970      22.000        .010       9.640     566.500   3410.000
     18      31       4.490      28.000        .020       5.000      79.500   2880.000
     19      24      15.980      25.000        .015      24.200     826.700   3970.000
  20     30          4.080     29.000        .028      4.550      67.100    1000.000
  21     29          3.570     35.000        .070      5.300      72.100    1070.000
  22     6950        9.200     45.000        .062      5.230      50.100    3730.000
  23     56         37.150     23.000        .015     14.580     660.200    8820.000
  24     5390       21.000     41.000        .024      8.580     219.100    7810.000
  25     5410        7.400     28.000        .030      5.680      62.000    2000.000
  26     5290       12.800     22.000        .028      8.330     203.000    5840.000
  27     65          9.290     34.000        .019      5.980     130.800    2810.000
  28     5300      146.000     24.000        .015     24.660    3525.000   22500.000
  29     6980      109.000     22.000        .020     27.000    1637.000   25900.000
  30     8515         .330     22.000        .313      1.160       1.330     137.000
  31     3131        1.070     14.000        .062      2.270      11.210     152.000
  32     6247         .230     33.000        .152       .880        .860      66.000
  33     6290         .380     24.000        .012       .900       3.380     112.000
  34     5305         .170     16.000        .133       .610        .380      22.000
  35     5380         .910     45.000        .234      1.520       2.160     511.000
  36     5977         .940     45.000        .054      1.590       5.710     724.000
  37     6003         .210     51.000        .062       .810       1.240     211.000
  38     5645        1.270     16.000        .053      2.390      20.450     159.000
  39     4260        1.310     58.000        .222      2.180       5.270     635.000
  40     8370        1.230     22.000        .174      2.140       9.070     317.000
  41     6280        1.790     26.000        .160      2.940       6.980     664.000
  42     18          1.870     24.000        .051      1.890       4.960     587.000


STATISTICS OF DATA

BASED ON   42 OBSERVATIONS
                                                     STANDARD
   VARIABLE          AVERAGE          VARIANCE       DEVIATION

       AREA            .7505            .5589           .7476
        MAP           1.4741            .0229           .1512
      SLOPE            .2157            .0137           .1171
     LENGTH           2.5165           1.3696          1.1703
        LLS          13.9564         205.8080         14.3460
      100YR           3.2784            .5822           .7630      DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

 VARIABLE      AREA        MAP      SLOPE     LENGTH        LLS      100YR
     AREA    1.0000      .0000    -.6681      .9310      .8056      .9607
      MAP     .0000     1.0000     .0000      .0000      .0000      .2897
    SLOPE   -.6681       .0000    1.0000     -.6386     -.5709     -.6212
   LENGTH    .9310       .0000    -.6386     1.0000      .8963      .8686
      LLS     .8056       .0000    -.5709      .8963     1.0000      .7248
    100YR     .9607       .2897    -.6212      .8686      .7248     1.0000


    INDEPENDENT          REGRESSION          PARTIAL
     VARIABLE            COEFFICIENT      DETERMINATION
                                           COEFFICIENT


         AREA              .992634           .7587
          MAP             1.007927           .5248
        SLOPE             -.100698           .0000
       LENGTH              .028285           .0000
          LLS             -.005763           .0389
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                                                       STANDARD
   REGRESSION             R              R BAR         ERROR OF
    CONSTANT            SQUARE           SQUARE        ESTIMATE
     1.078575           .9686            .9643           .1443

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                                               VARIABLE DELETED IS     SLOPE


   INDEPENDENT          REGRESSION          PARTIAL
    VARIABLE            COEFFICIENT       DETERMINATION
                                           COEFFICIENT

        AREA              1.002941           .7784
         MAP               .998648           .5258
      LENGTH               .027951           .0000
         LLS              -.005691           .0380

                                                       STANDARD
   REGRESSION             R              R BAR         ERROR OF
    CONSTANT            SQUARE           SQUARE        ESTIMATE
     1.062630           .9685            .9651           .1426

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                                               VARIABLE DELETED IS    LENGTH


   INDEPENDENT          REGRESSION          PARTIAL
    VARIABLE            COEFFICIENT       DETERMINATION
                                           COEFFICIENT

        AREA              1.029601           .9116
         MAP               .989190           .5270
         LLS              -.004765           .0542

                                                       STANDARD
   REGRESSION             R              R BAR         ERROR OF
    CONSTANT            SQUARE           SQUARE        ESTIMATE
     1.113984           .9684            .9659           .1410

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                                               VARIABLE DELETED IS       LLS


   INDEPENDENT          REGRESSION          PARTIAL
    VARIABLE            COEFFICIENT       DETERMINATION
                                           COEFFICIENT

        AREA               .954433           .9606
         MAP              1.027607           .5312
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                                                        STANDARD
   REGRESSION            R              R BAR           ERROR OF
    CONSTANT           SQUARE           SQUARE          ESTIMATE
     1.047257          .9657            .9639             .1450

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                                        VARIABLE DELETED IS       MAP


   INDEPENDENT         REGRESSION          PARTIAL
    VARIABLE          COEFFICIENT       DETERMINATION
                                         COEFFICIENT

       AREA              .981625            .9230

                                                        STANDARD
   REGRESSION            R              R BAR           ERROR OF
    CONSTANT           SQUARE           SQUARE          ESTIMATE
     2.541685          .9249            .9230             .2117

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1*********************************
    MULTIPLE LINEAR REGRESSION

    704-G1-L2020       JAN 1975
    REVISED            JAN 1983
 ********************************


  9S-LQ200 REG REG, HISTORICAL .5% FLOWS IN SANTA CLARA + SANTA CRUZ+OTHER SMALL
  DATA FROM 1996 STUDY UPDATED BY WENDY C IN 2002,INCLUDE ALL SMALL AREAS<2SQMI
  ATA FROM SMALL + LRGE DA. REMOVE fACTOR<=7, REMOVE 48820 (OUT OF AREA)



    NVAL    NCOMB    IPRNT    IFRMT    IDELE      DELTA
       7        0        0        0        0      .0000

                                               + + + + ANALYSIS NO  1 + + + +

                                               DEPENDENT VARIABLE --   200YR


    IDEP        .......TRANSFORMATION CODES........     NOBR     IRES    IFORC
       7        0 3 3 2 2 2 3 0 0 0 0 0 0 0 0 0 0 0        0        0        0


  VARIABLE     TRANSFORMATION
    1%FLOW           NOT USED
      AREA         COMMON LOG
       MAP         COMMON LOG
     SLOPE        SQUARE ROOT
    LENGTH        SQUARE ROOT
       LLS        SQUARE ROOT
    200YR          COMMON LOG


 INPUT DATA

 OBS NO   OBS ID        AREA          MAP        SLOPE      LENGTH          LLS      200YR
      1     6000      40.200       37.000         .025      15.930      914.000  14600.000
      2     6050     111.000       47.000         .007      19.700      905.000  45700.000
      3     6006      16.000       48.000         .029       8.280      248.700   9100.000
      4     6250      45.900       40.000         .006      19.150     3717.000  15800.000
      5     6002       6.200       44.000         .094       4.220       29.000   3020.000
      6     6030      11.100       45.000         .028       6.950      121.000  11400.000
      7     5980      12.200       40.000         .026       9.170      252.000   9570.000
      8     6150      17.300       27.000         .021       8.370      392.000   9510.000
      9     5969      10.200       34.000         .044       7.460      131.000   9280.000
     10     5915      10.600       35.000         .044       5.640       84.000   4230.000
     11     5970      12.300       34.000         .026       9.360      242.000   4830.000
     12     5940       7.100       26.000         .010       8.900      241.000   1980.000
     13     5920      27.800       31.000         .015      11.530      807.000   8760.000
     14     6600       7.300       25.000         .015       6.250      164.300   2170.000
     15       64      15.120       17.000         .055       8.750      183.400   4570.000
     16       33       2.540       22.000         .033       2.460       15.400    767.000
     17       26      13.970       22.000         .010       9.640      566.500   3740.000
     18       31       4.490       28.000         .020       5.000       79.500   3440.000
     19       24      15.980       25.000         .015      24.200      826.700   4400.000
     20       30       4.080       29.000         .028       4.550       67.100   1130.000
  21    29        3.570     35.000        .070      5.300     72.100   1230.000
  22    6950      9.200     45.000        .062      5.230     50.100   4620.000
  23    56       37.150     23.000        .015     14.580    660.200  10600.000
  24    5390     21.000     41.000        .024      8.580    219.100   8260.000
  25    5410      7.400     28.000        .030      5.680     62.000   2300.000
  26    5290     12.800     22.000        .028      8.330    203.000   6610.000
  27    65        9.290     34.000        .019      5.980    130.800   3090.000
  28    5300    146.000     24.000        .015     24.660   3525.000  25100.000
  29    6980    109.000     22.000        .020     27.000   1637.000  29300.000
  30    8515       .330     22.000        .313      1.160      1.330    168.000
  31    3131      1.070     14.000        .062      2.270     11.210    181.000
  32    6247       .230     33.000        .152       .880       .860     82.000
  33    6290       .380     24.000        .012       .900      3.380    119.000
  34    5305       .170     16.000        .133       .610       .380     25.000
  35    5380       .910     45.000        .234      1.520      2.160    587.000
  36    5977       .940     45.000        .054      1.590      5.710    827.000
  37    6003       .210     51.000        .062       .810      1.240    259.000
  38    5645      1.270     16.000        .053      2.390     20.450    250.000
  39    4260      1.310     58.000        .222      2.180      5.270    710.000
  40    8370      1.230     22.000        .174      2.140      9.070    396.000
  41    6280      1.790     26.000        .160      2.940      6.980    718.000
  42    18        1.870     24.000        .051      1.890      4.960    642.000


STATISTICS OF DATA

BASED ON   42 OBSERVATIONS
                                                  STANDARD
   VARIABLE          AVERAGE         VARIANCE     DEVIATION

      AREA             .7505           .5589        .7476
       MAP            1.4741           .0229        .1512
     SLOPE             .2157           .0137        .1171
    LENGTH            2.5165          1.3696       1.1703
       LLS           13.9564        205.8080      14.3460
     200YR            3.3428           .5713        .7558     DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

 VARIABLE     AREA       MAP      SLOPE     LENGTH       LLS      200YR
     AREA   1.0000     .0000    -.6681      .9310      .8056      .9606
      MAP    .0000    1.0000     .0000      .0000      .0000      .2868
    SLOPE   -.6681     .0000    1.0000     -.6386     -.5709     -.6189
   LENGTH    .9310     .0000    -.6386     1.0000      .8963      .8678
      LLS    .8056     .0000    -.5709      .8963     1.0000      .7234
    200YR    .9606     .2868    -.6189      .8678      .7234     1.0000


   INDEPENDENT        REGRESSION          PARTIAL
    VARIABLE          COEFFICIENT      DETERMINATION
                                        COEFFICIENT


        AREA            .992072            .7552
         MAP            .980481            .5061
       SLOPE          -.072165             .0000
      LENGTH            .025500            .0000
         LLS          -.005831             .0393
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                                                               STANDARD
   REGRESSION             R              R BAR                 ERROR OF
     CONSTANT           SQUARE           SQUARE                ESTIMATE
      1.185669          .9674            .9629                   .1455

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                                                   VARIABLE DELETED IS     SLOPE


   INDEPENDENT          REGRESSION          PARTIAL
     VARIABLE           COEFFICIENT       DETERMINATION
                                           COEFFICIENT

          AREA             .999459           .7745
           MAP             .973831           .5089
        LENGTH             .025261           .0000
           LLS            -.005780           .0389

                                                               STANDARD
   REGRESSION             R              R BAR                 ERROR OF
     CONSTANT           SQUARE           SQUARE                ESTIMATE
      1.174242          .9674            .9639                   .1437

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                                                   VARIABLE DELETED IS    LENGTH


   INDEPENDENT          REGRESSION          PARTIAL
     VARIABLE           COEFFICIENT       DETERMINATION
                                           COEFFICIENT

          AREA            1.023554           .9094
           MAP             .965284           .5107
           LLS            -.004943           .0586

                                                               STANDARD
   REGRESSION             R              R BAR                 ERROR OF
     CONSTANT           SQUARE           SQUARE                ESTIMATE
      1.220654          .9673            .9647                   .1420

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                                                   VARIABLE DELETED IS       LLS


   INDEPENDENT          REGRESSION          PARTIAL
     VARIABLE           COEFFICIENT       DETERMINATION
                                           COEFFICIENT

          AREA             .945581           .9591
           MAP            1.005134           .5149
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                                                    STANDARD
    REGRESSION            R            R BAR        ERROR OF
     CONSTANT          SQUARE          SQUARE       ESTIMATE
      1.151438          .9643          .9625          .1464

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                                           VARIABLE DELETED IS      MAP


    INDEPENDENT         REGRESSION          PARTIAL
      VARIABLE         COEFFICIENT       DETERMINATION
                                           COEFFICIENT

          AREA             .972178            .9227

                                                    STANDARD
    REGRESSION            R            R BAR        ERROR OF
     CONSTANT          SQUARE          SQUARE       ESTIMATE
      2.613184          .9246          .9227          .2102

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1*******************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
   REVISED            JAN 1983
 *******************************


  9V1D200 REG REG FOR HISTORICAL .5% 1-DAY FLOW IN SANTA CLARA COUNTY

  DATA OBTAINED FROM GLEN ET AL 1996 STUDY UPDATED BY WENDY C IN 2002

  REMOVE 57,32.ADD SANTA CRUZ DATA TO MATCH RAINFALL REGREG. REMOVE DATA < FACTO


   NVAL   NCOMB   IPRNT   IFRMT   IDELE     DELTA
      9       0       0       0       0     .0000


                                              + + + + ANALYSIS NO  1 + + + +

                                              DEPENDENT VARIABLE --     .5% V


   IDEP     .......TRANSFORMATION CODES........     NOBR     IRES     IFORC
      6     3 3 2 2 2 3 0 0 0 0 0 0 0 0 0 0 0 0        0        0         0


  VARIABLE     TRANSFORMATION
      AREA        COMMON LOG
       MAP        COMMON LOG
     SLOPE       SQUARE ROOT
    LENGTH       SQUARE ROOT
       LLS       SQUARE ROOT
     .5% V        COMMON LOG
      1% V          NOT USED
     10% V          NOT USED
     50% V          NOT USED


 INPUT DATA

 OBS NO  OBS ID      AREA        MAP      SLOPE     LENGTH        LLS      .5% V
      1    0000    40.200     36.950       .025     15.930    914.000   8730.000
      2    0500   111.000     47.000       .007     19.700    905.400  25600.000
      3    0060    16.000     48.350       .029      8.260    248.700   3890.000
      4    2500    45.900     40.360       .006     19.150   3717.500   7470.000
      5    0070    11.300     55.020       .012      7.520    231.200   1980.000
      6    0020     6.200     43.590       .094      4.220     28.600   1450.000
      7    0300    11.100     45.070       .028      6.950    121.500   3630.000
      8    9800    12.200     40.000       .026      9.170    251.900   3550.000
      9    1500    17.300     27.000       .021      8.370    392.000   4730.000
     10    9690    10.200     33.920       .044      7.460    130.900   2470.000
     11    9150    10.600     35.000       .044      5.640     83.600   1780.000
     12    9700    12.300     33.500       .026      9.360    242.000   1870.000
     13    9200    27.800     30.650       .015     11.530    807.500   3310.000
     14    2000   244.000     34.980       .013     28.910   3265.900  23100.000
     15    0500     9.400     20.220       .023      5.060    132.500    987.000
     16    6400   130.000     21.000       .006     32.350   5177.000  12200.000
     17    7500    42.000     19.000       .012     18.940   1276.000   4010.000
    18    6000      7.300      24.670       .015      6.250    164.300    661.000
    19    3500      7.500      32.000       .028      7.010    145.800   1210.000
    20    3200     77.100      25.000       .009     25.760   3239.000   6550.000
    21      33      2.540      22.250       .033      2.460     15.400    208.000
    22      26     13.970      21.620       .010      9.640    566.500   1220.000
    23    4500     37.400      32.360       .018     11.880    530.700   4370.000
    24    2100     21.500      21.700       .025     11.630    380.900    778.000
    25      31      4.490      28.070       .020      5.000     79.500    606.000
    26      24     15.980      25.070       .015     24.200    826.700   1270.000
    27      30      4.080      29.350       .028      4.550     67.100    530.000
    28      29      3.570      35.480       .070      5.300     72.100    582.000
    29      51      9.770      20.790       .011      6.210    177.000    706.000
    30    9500      9.200      44.890       .062      5.230     50.100   1420.000
    31    9800    109.000      23.760       .020     27.020   1636.600  12600.000
    32      56     37.150      23.190       .015     14.580    660.200   5540.000
    33    3900     21.000      41.200       .024      8.580    219.100   5040.000
    34    4100      7.400      28.460       .030      5.680     62.000    819.000
    35    2900     12.800      22.000       .028      8.330    203.000   1530.000
    36      65      9.290      34.520       .019      5.980    130.800   1440.000
    37    7500    206.000      16.500       .016     31.100   3912.000  12400.000


STATISTICS OF DATA

BASED ON   37 OBSERVATIONS
                                                         STANDARD
    VARIABLE            AVERAGE           VARIANCE       DEVIATION

        AREA             1.2605              .2420           .4919
         MAP             1.4784              .0175           .1322
       SLOPE              .1505              .0025           .0498
      LENGTH             3.2871             1.2537          1.1197
         LLS            22.9479           321.6828         17.9355
       .5% V             3.3910              .2452           .4952       DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

 VARIABLE     AREA        MAP      SLOPE     LENGTH        LLS      .5% V
     AREA   1.0000      .0000     -.5678      .9272      .8820      .9069
      MAP    .0000     1.0000      .2941     -.2137     -.2322      .0000
    SLOPE   -.5678      .2941     1.0000     -.5883     -.6189     -.4061
   LENGTH    .9272     -.2137     -.5883     1.0000      .9280      .7869
      LLS    .8820     -.2322     -.6189      .9280     1.0000      .7344
    .5% V    .9069      .0000     -.4061      .7869      .7344     1.0000


    INDEPENDENT          REGRESSION          PARTIAL
     VARIABLE            COEFFICIENT      DETERMINATION
                                           COEFFICIENT

        AREA              1.089775           .6540
         MAP              1.105754           .4778
       SLOPE               .253613           .0000
      LENGTH             -.032879            .0000
         LLS             -.001286            .0000

                                                         STANDARD
    REGRESSION              R              R BAR          ERROR OF
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     CONSTANT           SQUARE         SQUARE       ESTIMATE
       .481972          .9278          .9161          .1434

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                                           VARIABLE DELETED IS       LLS


    INDEPENDENT         REGRESSION        PARTIAL
      VARIABLE         COEFFICIENT     DETERMINATION
                                        COEFFICIENT

          AREA            1.082302        .6562
           MAP            1.111508        .4818
         SLOPE             .298628        .0000
        LENGTH            -.047595        .0000


                                                     STANDARD
    REGRESSION            R            R BAR         ERROR OF
     CONSTANT           SQUARE         SQUARE        ESTIMATE
       .494973          .9275          .9184          .1414

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                                           VARIABLE DELETED IS     SLOPE


    INDEPENDENT         REGRESSION        PARTIAL
      VARIABLE         COEFFICIENT     DETERMINATION
                                        COEFFICIENT

          AREA            1.072961        .6555
           MAP            1.135693        .5085
        LENGTH            -.051031        .0000


                                                     STANDARD
    REGRESSION            R            R BAR         ERROR OF
     CONSTANT           SQUARE         SQUARE        ESTIMATE
       .527238          .9270          .9203          .1398

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                                           VARIABLE DELETED IS    LENGTH


    INDEPENDENT         REGRESSION        PARTIAL
      VARIABLE         COEFFICIENT     DETERMINATION
                                        COEFFICIENT

          AREA             .967302        .9209
           MAP            1.188269        .5549


                                                     STANDARD
    REGRESSION            R            R BAR         ERROR OF
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     CONSTANT           SQUARE         SQUARE       ESTIMATE
       .414950          .9253          .9209          .1393

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                                           VARIABLE DELETED IS       MAP


    INDEPENDENT         REGRESSION           PARTIAL
      VARIABLE         COEFFICIENT        DETERMINATION
                                           COEFFICIENT

          AREA             .915688            .8224


                                                     STANDARD
    REGRESSION             R           R BAR         ERROR OF
     CONSTANT           SQUARE         SQUARE        ESTIMATE
      2.236754          .8273          .8224           .2087

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1*********************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
   REVISED            JAN 1983
 *********************************


  9V1D100 REG REG FOR HISTORICAL 1% 1-DAY FLOW IN SANTA CLARA COUNTY

  DATA OBTAINED FROM GLEN ET AL 1996 STUDY UPDATED BY WENDY C IN 2002

  REMOVE 57,32.ADD S.CRUZ DATA TO MATCH RAINFALL REGREG.REMOVE DATA<FACTO2


    NVAL    NCOMB    IPRNT    IFRMT    IDELE     DELTA
       9        0        0        0        0     .0000

                                              + + + + ANALYSIS NO  1 + + + +

                                              DEPENDENT VARIABLE --      1% V


    IDEP      .......TRANSFORMATION CODES........     NOBR     IRES     IFORC
       7     3 3 3 2 2 0 3 0 0 0 0 0 0 0 0 0 0 0          0        0        0


  VARIABLE    TRANSFORMATION
      AREA       COMMON LOG
       MAP       COMMON LOG
     SLOPE       COMMON LOG
    LENGTH      SQUARE ROOT
       LLS      SQUARE ROOT
     .5% V         NOT USED
      1% V       COMMON LOG
     10% V         NOT USED
     50% V         NOT USED


 INPUT DATA

 OBS NO   OBS ID       AREA        MAP       SLOPE     LENGTH        LLS        1% V
      1     0000     40.200     36.950      .025     15.930     914.000    7450.000
      2     0500    111.000     47.000      .007     19.700     905.400   21300.000
      3     0060     16.000     48.350      .029      8.260     248.700    3070.000
      4     2500     45.900     40.360      .006     19.150    3717.500    6320.000
      5     0070     11.300     55.020      .012      7.520     231.200    1780.000
      6     0020      6.200     43.590      .094      4.220      28.600    1180.000
      7     0300     11.100     45.070      .028      6.950     121.500    3060.000
      8     9800     12.200     40.000      .026      9.170     251.900    2970.000
      9     1500     17.300     27.000      .021      8.370     392.000    4030.000
     10     9690     10.200     33.920      .044      7.460     130.900    2060.000
     11     9150     10.600     35.000      .044      5.640      83.600    1550.000
     12     9700     12.300     33.500      .026      9.360     242.000    1580.000
     13     9200     27.800     30.650      .015     11.530     807.500    2830.000
     14     2000    244.000     34.980      .013     28.910    3265.900   20200.000
     15     0500      9.400     20.220      .023      5.060     132.500     830.000
     16     6400    130.000     21.000      .006     32.350    5177.000   10300.000
     17     7500     42.000     19.000      .012     18.940    1276.000    3290.000
 18    6000      7.300    24.670      .015    6.250   164.300    568.000
 19    3500      7.500    32.000      .028    7.010   145.800    981.000
 20    3200     77.100    25.000      .009   25.760  3239.000   6010.000
 21      33      2.540    22.250      .033    2.460    15.400    180.000
 22      26     13.970    21.620      .010    9.640   566.500   1060.000
 23    4500     37.400    32.360      .018   11.880   530.700   3850.000
 24    2100     21.500    21.700      .025   11.630   380.900    712.000
 25      31      4.490    28.070      .020    5.000    79.500    523.000
 26      24     15.980    25.070      .015   24.200   826.700   1140.000
 27      30      4.080    29.350      .028    4.550    67.100    452.000
 28      29      3.570    35.480      .070    5.300    72.100    492.000
 29      51      9.770    20.790      .011    6.210   177.000    610.000
 30    9500      9.200    44.890      .062    5.230    50.100   1210.000
 31    9800    109.000    23.760      .020   27.020  1636.600  11200.000
 32      56     37.150    23.190      .015   14.580   660.200   4490.000
 33    3900     21.000    41.200      .024    8.580   219.100   4440.000
 34    4100      7.400    28.460      .030    5.680    62.000    711.000
 35    2900     12.800    22.000      .028    8.330   203.000   1350.000
 36      65      9.290    34.520      .019    5.980   130.800   1290.000
 37    7500    206.000    16.500      .016   31.100  3912.000   9340.000


STATISTICS OF DATA

BASED ON   37 OBSERVATIONS
                                                 STANDARD
    VARIABLE          AVERAGE        VARIANCE    DEVIATION


        AREA           1.2605           .2420      .4919
         MAP           1.4784           .0175      .1322
       SLOPE          -1.6871           .0741      .2723
      LENGTH           3.2871          1.2537     1.1197
         LLS          22.9479        321.6828    17.9355
        1% V           3.3224           .2419      .4918      DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

 VARIABLE      AREA       MAP      SLOPE     LENGTH       LLS       1% V
     AREA    1.0000     .0000    -.6078      .9272     .8820      .9097
      MAP     .0000    1.0000     .2485     -.2137    -.2322      .0000
    SLOPE    -.6078     .2485    1.0000     -.6350    -.6937     -.4606
   LENGTH     .9272    -.2137    -.6350     1.0000     .9280      .7911
      LLS     .8820    -.2322    -.6937      .9280    1.0000      .7365
     1% V     .9097     .0000    -.4606      .7911     .7365     1.0000


    INDEPENDENT        REGRESSION         PARTIAL
     VARIABLE          COEFFICIENT     DETERMINATION
                                        COEFFICIENT


          AREA           1.071210          .6699
           MAP           1.117831          .5160
         SLOPE            .038024          .0000
        LENGTH          -.023596           .0000
           LLS          -.001473           .0000


                                                    STANDARD
    REGRESSION              R            R BAR      ERROR OF
   CONSTANT             SQUARE          SQUARE        ESTIMATE
     .495089            .9335           .9228          .1367

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                                            VARIABLE DELETED IS     SLOPE


  INDEPENDENT            REGRESSION          PARTIAL
   VARIABLE             COEFFICIENT       DETERMINATION
                                           COEFFICIENT

        AREA             1.068841            .6692
         MAP             1.127003            .5259
      LENGTH             -.022264            .0000
         LLS             -.001880            .0000

                                                          STANDARD
  REGRESSION                R             R BAR           ERROR OF
   CONSTANT              SQUARE           SQUARE          ESTIMATE
     .425326              .9333            .9249            .1347

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                                            VARIABLE DELETED IS    LENGTH


  INDEPENDENT            REGRESSION          PARTIAL
   VARIABLE             COEFFICIENT       DETERMINATION
                                           COEFFICIENT

        AREA             1.042873            .7643
         MAP             1.137445            .5387
         LLS             -.002520            .0000

                                                          STANDARD
  REGRESSION                R             R BAR           ERROR OF
   CONSTANT              SQUARE           SQUARE          ESTIMATE
     .384133              .9331            .9270            .1329

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                                            VARIABLE DELETED IS       LLS


  INDEPENDENT            REGRESSION          PARTIAL
   VARIABLE             COEFFICIENT       DETERMINATION
                                           COEFFICIENT

        AREA              .963642            .9274
         MAP             1.186631            .5790

                                                          STANDARD
  REGRESSION                R             R BAR           ERROR OF
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   CONSTANT             SQUARE         SQUARE        ESTIMATE
     .353447            .9314          .9274          .1325

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                                             VARIABLE DELETED IS      MAP


  INDEPENDENT          REGRESSION               PARTIAL
   VARIABLE           COEFFICIENT            DETERMINATION
                                              COEFFICIENT

        AREA              .912099                .8275


                                                             STANDARD
  REGRESSION              R              R BAR          ERROR OF
    CONSTANT            SQUARE           SQUARE         ESTIMATE
     2.172739           .8323            .8275            .2043

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1********************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
   REVISED            JAN 1983
 ********************************


 9V1D10 REG REG FOR HISTORICAL 10% 1-DAY FLOW IN SANTA CLARA COUNTY

 DATA OBTAINED FROM GLEN ET AL 1996 STUDY UPDATED BY WENDY C IN 2002

 REMOVE 57,32.ADD SANTA CRUZ DATA TO MATCH RAINFALL REGREG. REMOVE DATA < FACTO


   NVAL   NCOMB   IPRNT   IFRMT   IDELE     DELTA
      9       0       0       0       0     .0000

                                               + + + + ANALYSIS NO  1 + + + +

                                               DEPENDENT VARIABLE --     10% V


   IDEP      .......TRANSFORMATION CODES........   NOBR     IRES     IFORC
      8      3 3 3 2 2 0 0 3 0 0 0 0 0 0 0 0 0 0      0        0        0


 VARIABLE    TRANSFORMATION
     AREA       COMMON LOG
      MAP       COMMON LOG
    SLOPE       COMMON LOG
   LENGTH      SQUARE ROOT
      LLS      SQUARE ROOT
    .5% V         NOT USED
     1% V         NOT USED
    10% V       COMMON LOG
    50% V         NOT USED


 INPUT DATA

 OBS NO   OBS ID       AREA         MAP        SLOPE      LENGTH        LLS       10% V
     1     0000      40.200      36.950       .025      15.930     914.000    3270.000
     2     0500     111.000      47.000       .007      19.700     905.400    8890.000
     3     0060      16.000      48.350       .029       8.260     248.700    1080.000
     4     2500      45.900      40.360       .006      19.150    3717.500    2730.000
     5     0070      11.300      55.020       .012       7.520     231.200     993.000
     6     0020       6.200      43.590       .094       4.220      28.600     419.000
     7     0300      11.100      45.070       .028       6.950     121.500    1250.000
     8     9800      12.200      40.000       .026       9.170     251.900    1210.000
     9     1500      17.300      27.000       .021       8.370     392.000    1810.000
    10     9690      10.200      33.920       .044       7.460     130.900     795.000
    11     9150      10.600      35.000       .044       5.640      83.600     732.000
    12     9700      12.300      33.500       .026       9.360     242.000     647.000
    13     9200      27.800      30.650       .015      11.530     807.500    1270.000
    14     2000     244.000      34.980       .013      28.910    3265.900   10200.000
    15     0500       9.400      20.220       .023       5.060     132.500     305.000
    16     6400     130.000      21.000       .006      32.350    5177.000    3700.000
    17     7500      42.000      19.000       .012      18.940    1276.000    1220.000
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  18    6000      7.300    24.670       .015      6.250    164.300    267.000
  19    3500      7.500    32.000       .028      7.010    145.800    340.000
  20    3200     77.100    25.000       .009     25.760   3239.000   3570.000
  21      33      2.540    22.250       .033      2.460     15.400     89.000
  22      26     13.970    21.620       .010      9.640    566.500    527.000
  23    4500     37.400    32.360       .018     11.880    530.700   1920.000
  24    2100     21.500    21.700       .025     11.630    380.900    416.000
  25      31      4.490    28.070       .020      5.000     79.500    250.000
  26      24     15.980    25.070       .015     24.200    826.700    660.000
  27      30      4.080    29.350       .028      4.550     67.100    216.000
  28      29      3.570    35.480       .070      5.300     72.100    213.000
  29      51      9.770    20.790       .011      6.210    177.000    316.000
  30    9500      9.200    44.890       .062      5.230     50.100    558.000
  31    9800    109.000    23.760       .020     27.020   1636.600   5370.000
  32      56     37.150    23.190       .015     14.580    660.200   1340.000
  33    3900     21.000    41.200       .024      8.580    219.100   2370.000
  34    4100      7.400    28.460       .030      5.680     62.000    330.000
  35    2900     12.800    22.000       .028      8.330    203.000    635.000
  36      65      9.290    34.520       .019      5.980    130.800    687.000
  37    7500    206.000    16.500       .016     31.100   3912.000   2310.000


STATISTICS OF DATA

BASED ON    37 OBSERVATIONS
                                                         STANDARD
    VARIABLE           AVERAGE          VARIANCE         DEVIATION

        AREA            1.2605             .2420            .4919
         MAP            1.4784             .0175            .1322
       SLOPE           -1.6871             .0741            .2723
      LENGTH            3.2871            1.2537           1.1197
         LLS           22.9479          321.6828          17.9355
       10% V            2.9671             .2281            .4776     DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

 VARIABLE      AREA        MAP      SLOPE     LENGTH        LLS       10% V
     AREA    1.0000      .0000     -.6078      .9272      .8820      .9029
      MAP     .0000     1.0000      .2485     -.2137     -.2322      .0901
    SLOPE    -.6078      .2485     1.0000     -.6350     -.6937     -.4949
   LENGTH     .9272     -.2137     -.6350     1.0000      .9280      .7910
      LLS     .8820     -.2322     -.6937      .9280     1.0000      .7277
    10% V     .9029      .0901     -.4949      .7910      .7277     1.0000


    INDEPENDENT           REGRESSION            PARTIAL
     VARIABLE             COEFFICIENT         DETERMINATION
                                               COEFFICIENT


        AREA                .971897               .6605
         MAP               1.236229               .6052
       SLOPE               -.111370               .0005
      LENGTH                .027836               .0000
         LLS               -.004212               .0143


                                                          STANDARD
    REGRESSION               R              R BAR         ERROR OF
   CONSTANT              SQUARE          SQUARE       ESTIMATE
    -.268377             .9395           .9297          .1266

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                                              VARIABLE DELETED IS    LENGTH


  INDEPENDENT          REGRESSION          PARTIAL
   VARIABLE            COEFFICIENT      DETERMINATION
                                         COEFFICIENT

        AREA             1.004422            .7779
         MAP             1.222570            .6075
       SLOPE             -.108684            .0000
         LLS             -.003386            .0129


                                                        STANDARD
  REGRESSION               R              R BAR        ERROR OF
   CONSTANT              SQUARE          SQUARE        ESTIMATE
    -.212119              .9391           .9315          .1250

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                                              VARIABLE DELETED IS     SLOPE


  INDEPENDENT          REGRESSION          PARTIAL
   VARIABLE            COEFFICIENT      DETERMINATION
                                         COEFFICIENT

        AREA             1.006752            .7737
         MAP             1.198139            .5956
         LLS             -.002332            .0000


                                                        STANDARD
  REGRESSION               R              R BAR        ERROR OF
   CONSTANT              SQUARE          SQUARE        ESTIMATE
    -.019762              .9373           .9315          .1250

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                                              VARIABLE DELETED IS       LLS


  INDEPENDENT          REGRESSION          PARTIAL
   VARIABLE            COEFFICIENT      DETERMINATION
                                         COEFFICIENT

        AREA              .933455            .9314
         MAP             1.243642            .6319


                                                        STANDARD
  REGRESSION               R              R BAR        ERROR OF
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     CONSTANT           SQUARE         SQUARE       ESTIMATE
      -.048150          .9358          .9320          .1246

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                                           VARIABLE DELETED IS      MAP

    INDEPENDENT         REGRESSION           PARTIAL
      VARIABLE         COEFFICIENT        DETERMINATION
                                           COEFFICIENT

          AREA             .879435            .8152

                                                    STANDARD
    REGRESSION            R            R BAR        ERROR OF
     CONSTANT           SQUARE         SQUARE       ESTIMATE
      1.858548          .8203          .8152          .2053

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1********************************
    MULTIPLE LINEAR REGRESSION

    704-G1-L2020       JAN 1975
    REVISED            JAN 1983
 ********************************


  9V1D2 REG REG FOR HISTORICAL .5% 1-DAY FLOW IN SANTA CLARA COUNTY

  DATA OBTAINED FROM GLEN ET AL 1996 STUDY UPDATED BY WENDY C IN 2002

  REMOVE 57,32.ADD SANTA CRUZ DATA TO MATCH RAINFALL REGREG. REMOVE DATA < FACTO


    NVAL   NCOMB   IPRNT   IFRMT   IDELE     DELTA
       9       0       0       0       0     .0000

                                          + + + + ANALYSIS NO  1 + + + +

                                          DEPENDENT VARIABLE --     50% V


    IDEP     .......TRANSFORMATION CODES........   NOBR    IRES    IFORC
       9     3 3 2 2 2 0 0 0 3 0 0 0 0 0 0 0 0 0      0       0        0


  VARIABLE    TRANSFORMATION
      AREA       COMMON LOG
       MAP       COMMON LOG
     SLOPE      SQUARE ROOT
    LENGTH      SQUARE ROOT
       LLS      SQUARE ROOT
     .5% V         NOT USED
      1% V         NOT USED
     10% V         NOT USED
     50% V       COMMON LOG


  INPUT DATA

  OBS NO  OBS ID        AREA        MAP      SLOPE     LENGTH        LLS      50% V
       1    0000      40.200     36.950       .025     15.930    914.000    794.000
       2    0500     111.000     47.000       .007     19.700    905.400   2320.000
       3    0060      16.000     48.350       .029      8.260    248.700    269.000
       4    2500      45.900     40.360       .006     19.150   3717.500    705.000
       5    0070      11.300     55.020       .012      7.520    231.200    342.000
       6    0020       6.200     43.590       .094      4.220     28.600     79.000
       7    0300      11.100     45.070       .028      6.950    121.500    270.000
       8    9800      12.200     40.000       .026      9.170    251.900    282.000
       9    1500      17.300     27.000       .021      8.370    392.000    497.000
      10    9690      10.200     33.920       .044      7.460    130.900    156.000
      11    9150      10.600     35.000       .044      5.640     83.600    187.000
      12    9700      12.300     33.500       .026      9.360    242.000    140.000
      13    9200      27.800     30.650       .015     11.530    807.500    320.000
      14    2000     244.000     34.980       .013     28.910   3265.900   3410.000
      15    0500       9.400     20.220       .023      5.060    132.500     44.000
      16    6400     130.000     21.000       .006     32.350   5177.000    508.000
      17    7500      42.000     19.000       .012     18.940   1276.000    244.000
 18    6000      7.300     24.670       .015      6.250    164.300     78.000
 19    3500      7.500     32.000       .028      7.010    145.800     61.000
 20    3200     77.100     25.000       .009     25.760   3239.000   1200.000
 21      33      2.540     22.250       .033      2.460     15.400     28.000
 22      26     13.970     21.620       .010      9.640    566.500    170.000
 23    4500     37.400     32.360       .018     11.880    530.700    542.000
 24    2100     21.500     21.700       .025     11.630    380.900    135.000
 25      31      4.490     28.070       .020      5.000     79.500     76.000
 26      24     15.980     25.070       .015     24.200    826.700    274.000
 27      30      4.080     29.350       .028      4.550     67.100     74.000
 28      29      3.570     35.480       .070      5.300     72.100     55.000
 29      51      9.770     20.790       .011      6.210    177.000    126.000
 30    9500      9.200     44.890       .062      5.230     50.100    171.000
 31    9800    109.000     23.760       .020     27.020   1636.600   1150.000
 32      56     37.150     23.190       .015     14.580    660.200    127.000
 33    3900     21.000     41.200       .024      8.580    219.100    856.000
 34    4100      7.400     28.460       .030      5.680     62.000     81.000
 35    2900     12.800     22.000       .028      8.330    203.000    131.000
 36      65      9.290     34.520       .019      5.980    130.800    202.000
 37    7500    206.000     16.500       .016     31.100   3912.000    242.000


STATISTICS OF DATA

BASED ON    37 OBSERVATIONS
                                                          STANDARD
    VARIABLE             AVERAGE           VARIANCE       DEVIATION

        AREA              1.2605             .2420           .4919
         MAP              1.4784             .0175           .1322
       SLOPE               .1505             .0025           .0498
      LENGTH              3.2871            1.2537          1.1197
         LLS             22.9479          321.6828         17.9355
       50% V              2.3597             .2287           .4782      DEPENDENT VARIABLE


SIMPLE CORRELATION COEFFICIENTS

  VARIABLE       AREA         MAP       SLOPE      LENGTH         LLS       50% V
      AREA     1.0000       .0000     -.5678       .9272       .8820       .8125
       MAP      .0000      1.0000      .2941     -.2137      -.2322       .2211
     SLOPE    -.5678       .2941     1.0000     -.5883      -.6189      -.4715
    LENGTH     .9272      -.2137     -.5883     1.0000       .9280       .7167
       LLS     .8820      -.2322     -.6189       .9280      1.0000       .6461
     50% V     .8125       .2211     -.4715       .7167       .6461      1.0000


    INDEPENDENT          REGRESSION            PARTIAL
     VARIABLE            COEFFICIENT        DETERMINATION
                                             COEFFICIENT


         AREA               .731423              .3258
          MAP              1.683723              .5600
        SLOPE             -2.045897              .1377
       LENGTH               .105313              .0050
          LLS              -.006400              .0212


                                                          STANDARD
    REGRESSION               R              R BAR         ERROR OF
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   CONSTANT              SQUARE          SQUARE        ESTIMATE
    -.942745             .8696           .8486           .1860

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                                            VARIABLE DELETED IS    LENGTH


  INDEPENDENT          REGRESSION           PARTIAL
   VARIABLE            COEFFICIENT       DETERMINATION
                                          COEFFICIENT

        AREA              .854708           .5248
         MAP             1.632657           .5440
       SLOPE            -2.022125           .1303
         LLS             -.003344           .0000

                                                     STANDARD
  REGRESSION               R            R BAR        ERROR OF
   CONSTANT              SQUARE         SQUARE       ESTIMATE
    -.750191             .8648          .8479          .1865
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                                            VARIABLE DELETED IS       LLS


  INDEPENDENT          REGRESSION           PARTIAL
   VARIABLE            COEFFICIENT       DETERMINATION
                                          COEFFICIENT

        AREA              .758523           .7357
         MAP             1.682849           .5688
       SLOPE            -1.859769           .1140

                                                     STANDARD
  REGRESSION               R            R BAR        ERROR OF
   CONSTANT              SQUARE         SQUARE       ESTIMATE
    -.804339             .8618          .8493          .1856
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                                            VARIABLE DELETED IS    SLOPE


  INDEPENDENT          REGRESSION           PARTIAL
   VARIABLE            COEFFICIENT       DETERMINATION
                                          COEFFICIENT

        AREA              .860998           .8212
         MAP             1.510186           .4995

                                                     STANDARD
  REGRESSION               R            R BAR        ERROR OF
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      CONSTANT                 SQUARE          SQUARE       ESTIMATE
       -.958195                .8394           .8299          .1972

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                                              VARIABLE DELETED IS      MAP

     INDEPENDENT               REGRESSION             PARTIAL
      VARIABLE                 COEFFICIENT         DETERMINATION
                                                    COEFFICIENT

           AREA                   .795401              .6601

                                                                 STANDARD
     REGRESSION                  R             R BAR             ERROR OF
      CONSTANT                 SQUARE          SQUARE            ESTIMATE
       1.357157                .6696           .6601               .2788

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11 APPENDIX 3: MONOTONIC FREQUENCY CURVES

GRAPH PAPER

APPENDIX - 3

DATA FOR APPENDIX-3

LLAGAS CREEK HYDROLOGY

2003

		Basin Characteristics					2003 FINAL QUANTILES								Notes
								FLOOD PEAKS			VOLUMES				
Basin	C. Pt.	Area (sq. mi)	MAP (in)	Sm (ft/ft)	Lm (mi)	LLS (mi.mi)	9S-L 200	9S-L 100	9S-L 10	9S-L 2	200 24HR	100 24HR	10 24HR	2 24HR	
A	1	19.2	33.0	0.012	11.92	693	7782	6892	3343	943	3316	2840	1256	398	Curve-1
B	2	3.31	25.0	0.002	2.63	96	1116	968	425	109	436	375	172	58	Curve-3
C	4	5	24.0	0.008	4.72	101	1582	1375	609	155	618	532	241	77	Curve-2